SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

NOVEMBER 1900.

GENERAL PHYSICS.

2127. *Gravity and Temperature below the Earth's Surface.* **R. v. Sterneck.** (Akad. Wiss. Wien, Sitzb. 108. pp. 697–766, 1899.)—Observations of the acceleration due to gravity and of the temperature have been made in three mines in Bohemia, and in the well-known quicksilver-mine at Idria in Craniola [see Abstract No. 1986 (1900)]. The copious results hardly admit of generalisation, but they seem to indicate that there is a tendency for an increase in temperature downwards to be associated with an increase in gravity, and, the larger the increase of the one, the larger appears to be the increase of the other. A. G.

2128. *Strength of Ductile Materials under Combined Stress.* **J. J. Guest.** (Phil. Mag. 50. pp. 69–132, July, 1900. Paper read before the Physical Society of London.)—The author discusses the present state of knowledge regarding the laws of strength, discusses the criterion of strength, choosing the yield-point rather than the ultimate stress in tensile tests, and the nature of the elastic limit in reference to the yield-point. The elastic limit effect may be mainly due to local yielding; the author has therefore assumed that Hooke's law held up to that point.

Previous experiments upon the yield-point under combined stress have usually been on torsion; those of Kelvin on piano wire show that simultaneous tension lowered the yield-point in torsion. Torsion presents a case of combined stresses, the two principal stresses being equal in amount but opposite in sign, while the third is zero. A large number of tests have been made on round bars, but the essentials of the phenomena are masked by the variation of strain from the axis outwards; to avoid this, the author conducted his experiments upon thin tubes, the thickness of the walls being from $\frac{1}{20}$ to $\frac{1}{25}$ the radius. Further, the tubular specimens could be easily subjected to internal fluid pressure simultaneously with tension or torsion.

The method of experimenting was to subject the tubes to torque and tension combined, to tension only, to tension and internal pressure combined, to torsion and internal pressure combined, and to internal pressure only; and to take measurements of the principal strains. The range of the two principal stresses thus covered was from $-p$ and $+p$ to $+p$ and $+p$, the third principal stress being small or zero.

The specimens were of tubes (steel, copper, and brass) soldered on to holders which served to apply the tension loads and the torques, and to introduce fluid under pressure to the interior of the tubes. The size of tube was 1¼ inches diameter with walls from 0·025 inch to 0·086 inch thick. The tension loads were applied by a 10-ton Wickstead machine, and special apparatus, which is fully described, was designed for the application of the torque and internal pressure. A new type of pressure gauge was made, consisting of a steel tube of oval section twisted so that the tube had a straight axis, but the extremities of the major axes of the sections perpendicular to the tube axis lay on a pair of helices of about 45° to 60° angle. A new extensometer on the lever and mirror system was made, the extensions being read by telescope and scale as in the Unwin extensometer. A new twist measuring apparatus consisting of two mirrors and a scale placed horizontally and read by light reflected at each of the mirrors was devised. The normals to the mirrors were inclined about 45° to the axis of the specimen. If the normals to the mirror are perpendicular to the specimen, the reflected optical axis is turned through twice the angle the specimen twists through. By allowing a ray of light after reflection from the two mirrors to fall upon a scale, the device forms a cheap and convenient form of transmission dynamometer, since the reading can be taken when the light is intermittent. A diametral extensometer was designed, and is described in the paper.

The method of making the tests is fully described, as well as the methods of determining the sectional area and thickness of the tubes. The results of the experiments show that the material and shape of the tubes are such as to give reliable results. Throughout a series of tests on any tube the yield-point stress has nearly the same value in tests of the same type. The maximum principal stress varies very largely, its least value being found in the pure torsion tests, while in the tests by tension and internal pressure its value is practically constant. The maximum principal strain varies throughout the experiments, it is greatest in the simple tension experiments, and least either in the torsion tests or when the axial and circumferential tensions are equal. The variations of the maximum strain are considerable for all the materials experimented on. The maximum shearing stress, and the maximum shearing strain or slide are comparatively constant, although the amount is highest in the case of pure torsion. The principal conclusion drawn from these experiments, as applicable to practice, is that the conditions for initial yield of a uniform ductile material is the existence of a specific shearing stress, and that the intermediate principal stress is without effect.

The paper is accompanied by numerous illustrations of the apparatus employed, and tables and diagrams giving the results of the tests. A. S.

2129. *New System of Units.* **F. J. Rogers.** (Phys. Rev. 11. pp. 115–116, Aug., 1900.)—To avoid the large numbers which the c.g.s. system of units introduces into practical work, the author proposes the M.K.S. or meter-kilogramme second system. The only new unit introduced by adopting this system is a “ Large Dyne ” $= 1$ kg. $\frac{\text{m}}{\text{sec}^2}$. The units of power and work become 1 watt and 1 joule respectively. G. H. B.

2130. *Balances for Automatic Weight Exchange.* **H. Stadthagen.** (Zeitschr. Instrumentenk. 20. pp. 206–207, July, 1900.)—In balances of this type, the weight is supported, not by a tray, but by a cross or a Y. When, however, a combination of $200 + 200 + 100$ g. is to be compared with one weight of 500 g., some kind of tray has to be resorted to. To avoid this necessity, Stückrath in Friedenau has constructed a kind of grate support, open in front and at the sides, on which combinations can be placed. The balance has been supplied for the German standardising department, along with weights up to 25 kg., and is made partly of the aluminium alloy partinium. There is no detailed description or diagram. H. B.

2131. *Physical Properties of Cobalt and Nickel.* **E. van Aubel.** (Archives des Sciences, 10. pp. 144–148, Aug., 1900.)—Two properties of these metals in the pure state have been accurately determined, viz., the coefficient of expansion and the specific heat.

Coefficients of Expansion.

Pure nickel	$10^{-8}(1248 + 0{\cdot}74t)$
„ cobalt	$10^{-8}(1208 + 0{\cdot}64t)$

Specific Heat.

	Nickel.	Cobalt.
Between 100° and 15°	0·10842	0·10303
„ 15° and − 78·4	0·0975	0·0939
„ 15° and − 182·4	0·0838	0·0822

The difference between the specific heats therefore increases as the temperature rises.

According to the results of Pionchon the specific heat of nickel is at first a little greater than that of cobalt, and becomes very much less at higher temperatures.

The electrical resistance is very different for the two metals :—

Silver	100
Cobalt	17·22
Nickel	13·11

The author points out that sodium and magnesium, aluminium and silicon, sulphur and phosphorus, which taken two and two present but small differences in atomic weight, are widely different in their coefficients of expansion and fusion-points. W. C. O.

2132. *Automatic Mercury Air-Pump.* **F. Neesen.** (Zeitschr. Instrumentenk. 20. pp. 205–206, July, 1900.)—The author describes improvements in his air-pumps, which were referred to in Abstract No. 1461 (1899). The capillary connection between the horizontal tubular recipient and the barometer tube contains several bends and bulbs, and the auxiliary starting pump branches off from it. From the other end of the recipient start the charging and the return pipes, connected below with a second cylindrical glass vessel which communicates by rubber tubing with a pair of small bulbs, suspended from the three-way cock ; the weight of these bulbs is partly counterbalanced. When the auxiliary pump acts, the mercury will rush from the bulbs, so that the counterpoise will throw the cock over, breaking the communication between the lower cylindrical vessel and the outer air ; the bulbs will then be refilled with mercury and pull the cock back again. The pump works quietly, and the improvements permit of a rapid flow of the mercury through the capillary. H. B.

2133. *Annual Report of Physikalisch-Technische Reichsanstalt.* (Zeitschr. Instrumentenk. 20. pp. 140–150, May, and 172–186, June, 1900. Extract from the report on the work of the Reichsanstalt, presented in March, 1900.) —These papers contain an abstract of the work done in the Reichsanstalt from Feb., 1899, to Feb., 1900, and, extending as this abstract does to twenty-four pages of the Zeitschrift, if again abstracted, the final abstract can only form an index to the valuable work contained in the original report.

The number of persons engaged in the Institute was 87. The work is divided into two classes according to the departments in which it is done. One department deals only with Research and the other with Standardising. Each department is again divided up into laboratories for heat, light, electricity, &c. In the Research Department the following subjects have been experimentally treated during the year :—

Heat.—Density of water. Vapour pressure of water at low temperatures. Vapour pressures of water near the temperature 50° C. Density of water vapour. Thermometers. Air-thermometers for high temperatures. Thermometers for very low temperatures. Electric heating. Ratio of heat conductivity to electric conductivity of metals. Fizeau-Abbe's Dilatometer. Passage of heat through hot-plates.

Electric.—Standard resistances. Capacity of condensers and its constancy. Standard cells. Conductivity of electrolytes.

Optics.—Light emission of a black body and temperature. Proof of Stefan's law between 90° and 1,700° abs. Unit of illumination. Absolute measurement of radiation. Distribution of energy in the spectrum of black bodies. Distribution of energy in the spectrum of polished platinum and other bodies, also their reflecting powers.

The work done in the Standardising department is divided into six classes : —Mechanical, Electrical, Heat and Pressure, Optics, Chemistry and Workshop, and as the fourteen pages in the papers which are devoted to the work of this department do not contain much more than a list of the different headings of the year's work and the numbers of the different kinds of instruments which have been tested, it is impossible to reproduce them here. J. B. H.

2134. *Stereoscopic Lissajous Curves.* **M. Dechevrens.** (Comptes Rendus, 131. pp. 408–410, Aug. 13, 1900.)—The author describes a curious property of his "campylograph" [see Abstract 1767 (1900)], which traces Lissajous figures on a revolving plate. When two consecutive figures are traced, and the second has a slightly different phase-relation from the first, the two figures have stereoscopic properties. Viewed in a stereoscope, the curves appear to consist of a continuous wire mounting upwards, and inscribed in a cylinder or sphere. The author explains this effect by showing that there is an apparent difference in the axis of revolution in the two figures. E. E. F.

2135. *Fractionating Rain-Gauge.* **J. Joly.** (Roy. Dublin Soc., Proc. 9. pp. 283–288, March 8, 1900.)—In order to determine the amount of sodium chloride carried by the atmosphere, which decreases as the air travels from the sea inland, the author has constructed a rain-gauge which fills separate bottles with definite quantities, *e.g.*, 0·1 inch, of rain. From the funnel the rain passes through a narrow tube, and then through a wider one, into the reservoir, into which dip the shorter legs of a number of siphons, fixed in different bottles. The bends of the various siphons are at different levels, so that they function one after the other. A second siphon may be placed in the bottle so that successive tenth parts can be withdrawn. In order to ensure cessation of the action of the siphon as soon as the corresponding bottle is full, the short limb consists of a rubber tube, surrounded by a glass tube, and ending in a wide-mouthed funnel, resembling an inverted bell. When the water in the reservoir sinks below the level of this bell-shaped siphon limb, a mixture of air and water will be sucked up, and a premature flow might ensue. The bell-mouth being wide and elastically suspended by a piece of rubber tubing, the rubber will be stretched as long as the bell is still full of water, and contract as soon as the mouth is finally uncovered. H. B.

2136. *Areometer Barometer.* **K. T. Fischer.** (Phys. Zeitschr. 1. pp. 394–396, June 16, 1900.)—This barometer is designed for balloon observations, as ordinary barometers indicate too low during the rise and too high during the fall of the balloon. The instrument may be described as a Cartesian diver. The float consists of stem, cylinder partly filled with water, the free space being taken up by air, and bulb charged with mercury; it is made of glass and swims in a brass cylinder containing distilled water. This cylinder is surrounded by a shell of ice, placed within a chamber packed with ice. The temperature being thus kept constant, the position of the float will depend upon the volume of the air intercepted in the float, which varies with the atmospheric pressure acting on the water in the brass cylinder. For exact determinations the stem is sealed off, and the cylindrical part weighed together with the bulb. Experiments, made in lifts and balloons, show that the instrument is not affected by upward or downward movement, and laboratory comparisons with an aneroid mark the superiority of the new barometer which gives identical curves for increasing and decreasing pressures. H. B.

2137. *Lake Levels and Wind Phenomena.* **A. J. Henry.** (Monthly Weather Rev. 28. pp. 203–205, May, 1900; reprinted from the Lake Chart for July, 1900.)—This paper deals with the changes in the level of Lake Erie, as observed at Amherstburg, Ontario, and Buffalo Harbour, the two stations being situated respectively at the western and eastern extremities of the lake. The curves reproduced concern the periods March 4–10, and March 22–29, 1900. During the first period, a storm moved from the Mississippi Valley in a northerly direction across the Lake region. The water rose at Amherstburg, fell, and rose again, and the converse fluctuations were observed at Buffalo. These fluctuations are due to the north-easterly wind in front of the advancing storm, and the shifting or backing of the wind to south-west; as the storm centre advanced, a second oscillation followed in the opposite sense. The amplitude of the oscillation may reach the extreme value of 7 feet. In the second case, a storm moved right east across the lake with considerably smaller velocity; the wind backed to north-west, and the oscillation was transverse rather than longitudinal. The synchronism of high water at Amherstburg and low water at Buffalo was almost perfect. The period of a complete oscillation was from twelve to sixteen hours; assuming the lake to have a mean depth of 50 feet, a period of seventeen hours would be computed. The oscillations are stationary rather than progressive, the whole lake oscillating about a nodal line; dangerous currents are not engendered in mid-lake. The oscillations do not appear to occur with all storms, and a given wind velocity does not produce a corresponding change in the water level, but forecasts could probably be made of the more pronounced oscillations. H. B.

2138. *Van der Waals' Thermodynamic Theory of Capillarity.* **G. Bakker.** (Zeitschr. Phys. Chem. 34. pp. 168–178, July 17, 1900.)—Van der Waals, in the last chapter of his work, finds for the energy per unit of mass at a point of a capillary layer between two parallel planes, with continuous variation of density, the expression—

$$\epsilon = \mathrm{C} - a\rho - \frac{c_2}{1.2}\frac{d^2\rho}{dh^2} - \frac{c_4}{1.2.3.4}\frac{d^4\rho}{dh^4} - \&\mathrm{c}.$$

Here a, c_2, c_4, &c., are integrals depending on the law of force only. With the exception of his last chapter, van der Waals in all his work uses the first three terms of this series alone as a sufficient approximation. In the last chapter he himself raises the question whether the remaining terms are really negligible.

Bakker, in the present paper, shows that on van der Waals' assumption of the potential function $\frac{1}{r}\epsilon^{-\frac{r}{\lambda}}$, the terms after the third are not negligible. He gives also a different method of obtaining the general differential equation of van der Waals, and concludes that van der Waals' last chapter must be separated from the rest of his work; as, if it be right, the calculation of density and capillary energy in the rest of the work require modification.

In paragraph (2) the author discusses the thermal pressure at a point in the transition layer, and concludes that it has the same value as it would have if the fluid were homogeneous and of the same density as at the point considered. He then, in (3), determines the differential equation which V, the potential function, satisfies. In paragraph (4) he discusses the capillary energy, and criticises some statements of van der Waals [see also Abstract No. 1320 (1899).] S. H. B.

2139. *Theory of Capillarity, II.* **G. Bakker.** (Journ. de Physique, 9. pp. 394–404, July, 1900.)—The writer assumes a fluid bounded by an infinite plane, taken for that of yz, and the forces excited on a particle near the surface to be derived from a potential ψ, which diminishes very rapidly as x increases from zero, so that we may write $\psi = \mathrm{A}\epsilon^{-qx}$.

He proves several mathematical theorems, using a form of potential like that of Carl Neumann, namely, $\phi(r) = \frac{\mathrm{A}\epsilon^{-qr} + \mathrm{B}\epsilon^{qr}}{r}$; but if the force function diminishes as r increases, A must be negative and B zero, so that the form finally adopted is $\phi(r) = -f\epsilon^{-qr}/r$.

The author then points out that the analogy of the pairs of equations—

$$\left.\begin{aligned}\nabla^2\psi &= 4\pi f\rho\\ \psi &= -\frac{f}{r}\end{aligned}\right\}$$

and—

$$\left.\begin{aligned}\nabla^2\psi &= q^2\psi + 4\pi f\rho\\ \psi &= -f\frac{\epsilon^{-qr}}{r}\end{aligned}\right\}$$

leads him to seek, in the theory of capillarity, equations analogous to those discovered by Maxwell for energy and tension in the theory of electrostatics, and with this discussion the latter part of the memoir is occupied [see also Abstract No. 31 (1900).] S. H. B.

2140. *Motion Produced in an Infinite Elastic Solid by the Motion through the Space occupied by it of a Body acting on it only by Attraction or Repulsion.*

Kelvin. (Phil. Mag. 50. pp. 181–198, Aug., 1900. Paper read before the Royal Society of Edinburgh, July, 1900.)—The author supposes a spherical portion of space occupied by matter which attracts or repels every portion of the infinite elastic solid representing ether with a force varying as the inverse square of the distance. The force is thus of the form $\frac{a}{r^2}$, where r is the distance and a denotes the intensity of the attractive quality for ether of the matter considered, and is negative when the force is repulsive. The system of matter within the spherical space is called an atom. It is assumed that integrating throughout the atom, $\int\int r^2 a dr = 0$. The author further assumes the distribution of positive and negative density within the atom, and the law of compressibility of the ether, to be such that the average density of the ether within the atom is equal to the undisturbed density of the ether outside. On these assumptions he works out the mathematics of his subject with the aid of diagrams. Two problems are solved, viz.: (1) to find the orbit of a particle of ether as disturbed by the moving atom; (2) to find the path traced through the atom, supposed fixed, while the surrounding ether is supposed to move uniformly in parallel lines. Also the effect on the refractive index is considered, due to assumed densities of ether at points within the atom.

In conclusion the author refers to the Michelson-Morley experiment (Phil. Mag., Dec., 1887, discussed also by Larmor, Ether and Matter, p. 46) as creating a difficulty. He can find no flaw either in the idea or the execution of this experiment, but thinks that a suggestion due to Fitzgerald that the stone slab used in that experiment has, by virtue of its translation through ether, its linear dimensions shortened by a minute portion, affords a means of escape from the difficulty. S. H. B.

2141. *The Duties of Ether for Electricity and Magnetism.* **Kelvin.** (Phil. Mag. 50. pp. 305–307, Sept., 1900.)—This is a short supplement to the author's paper in the Phil. Mag., Aug., 1900 [see preceding Abstract]. It is the substance of a statement made by the writer to the Congrès International de Physique in Paris on August 8. The writer seeks to explain how, if a positive electron condenses ether in its neighbourhood by attraction, and a negative electron rarifies it by repulsion, it comes about that the two attract each other according to the Newtonian law. He then goes on to explain how the ether, being, as he shows, "freed from the impossible task of transmitting both electrostatic and magnetic force," may be competent to perform the simpler duty of transmitting magnetic force alone. S. H. B.

2142. *Constitution of the Atmosphere at Various Heights.* **G. Hinrichs.** (Comptes Rendus, 131. pp. 442–443, Aug. 20, 1900.)—Working from the formula connecting the pressure and density of a gas, the author calculates the percentage composition of the atmosphere at intervals of 10,000 metres [6·2 miles], and gives a table showing the order in which the several constituents are left behind. At an altitude of over 60 miles the atmosphere will consist mainly (95 per cent.) of hydrogen, and the author suggests that this may be the source of the occluded hydrogen usually found in meteoric fragments. C. P. B.

2143. *The Classes of Progressive Long Waves.* **R. F. Gwyther.** (Phil. Mag. 50. pp. 213–216, Aug., and pp. 308–312, Sept., 1900.)—The author adopts

Rayleigh's method, but, instead of obtaining a differential equation approximately related to the free surface, he eliminates the vertical co-ordinate from the stream function and the condition for uniformity of pressure along the free surface. Approximate solutions of the resulting functional equation lead to three classes of long waves. The first class is of small amplitude. The second class appears to be connected with the stationary cnoidal wave of Korteweg and de Vries; a particular case is the low solitary wave of Scott Russell, for which the method determines the potential and stream functions assumed by McCowan in his investigation of the properties of that wave. The third class is the most general case of elliptic function waves.

In order to test the method of approximation adopted in the first of these papers the author pursues the investigation to a higher order of approximation, particularly in the case of the solitary wave. The approximate identity of a formula arrived at, and one demonstrated by Stokes for the outskirts of a solitary wave, forms the condition for the existence of a solitary wave of a certain amplitude. As under proper restrictions we know that such a wave is capable of propagation, the comparison of the relations under these circumstances is the proper test of the author's mode of treatment of the problem. The expressions are found to be in approximate agreement.

W. E. T.

2144. *Actinometric Observations during Total Solar Eclipse.* **J. Violle.** (Comptes Rendus, 130. pp. 1658-1661, June 18, 1900.)—During the total eclipse of May 28, 1900, the author provided for actinometric observations in two series, one by means of an apparatus attached to a captive balloon, the other on the summit of the Pic du Midi (altitude 2,860 m.). The results are plotted as curves, and show a close agreement with theoretical calculations computed from the varying amounts of the solar disc obscured during the progress of the eclipse. C. P. B.

2145. *Physical Meaning of Star-Magnitude.* **R. de Kövesligethy.** (Astrophys. Journ. 11. pp. 350-356, June, 1900.)—This paper is an attempt to connect the varying degrees of stellar magnitude with the physical condition of the star rather than regard it as a measure of the relative distance of bodies of intrinsically equal brightness. The author obtains an integral formula for the spectrum, and specialises it for the different types of stars, determining the constants by actual photometric measures of standard type stars. On such supposition a change in magnitude may be given in terms of, say, change in temperature. For example, if a *white* star changes in magnitude by *one* order it may be said to be the same as if its superficial temperature fell from 6,400° to 5,274°, or on another assumption to 5,230°.

The theory may be usefully extended to the study of new stars, &c., as showing the probable degree of increase of temperature with luminosity. Nova T Corona increased by three magnitudes in about 2¼ hours, which would correspond to an increase of about 0·5° C. per second. C. P. B.

REFERENCES.

2146. *Variation of Atmospheric Pressure and Moon's Declination.* **R. Börnstein.** (Phys. Zeitschr. 1. pp. 446-448, July 14, 1900.)—This is a continuation of the paper referred to in Abstract No. 1246 (1900). Curves are given showing the mean variation of atmospheric pressure during the lunar month at Berlin for various times during the period 1884-1898. C. P. B.

2147. *Recent Studies in Gravitation.* **J. H. Poynting.** (Nature, 62. pp. 403–408, Aug. 23, 1900. Paper read before the Royal Institution, Feb. 23, 1900.)

2148. *Stellar Spectra.* **Cornu.** (Bureau des Longitudes, Ann. pp. 299–306, 1900.)—A brief review of the various classes recognised in the study of stellar spectroscopy, with a map illustrating the distinctive features of each group. Reference is made to the determination of motions in the line of sight. C. P. B.

2149. *Orientation of Field of Siderostat and Cœlostat.* **A. Fowler.** (Nature, 62. pp. 428–430, Aug. 30, 1900.)—This is a discussion of a paper by Cornu [see Abstract No. 1032 (1900)], with additional formulæ to extend the problem to the cœlostat; an instrument consisting of a plane mirror having a single motion, parallel to the diurnal motion of the earth, but at only half the rate, making one revolution in forty-eight hours. A photograph is given of the instrument in position for observatory use. C. P. B.

2150. *Discussion of Nebular Hypothesis.* **T. C. Chamberlin** and **F. R. Moulton.** (Science, 12. pp. 201–208, Aug. 10, 1900.)—This paper is condensed from several others given by the authors at various times, discussing the discrepancies between the conclusions of the Laplacian theory and those indicated by modern mathematical analysis of the conditions governing gaseous masses. [See also Abstracts Nos. 805 and 997 (1900).] C. P. B.

2151. *Total Solar Eclipse, May* 28, 1900. (Frank. Inst., Journ. 150. pp. 133–151, August, 1900.)—Observation by Watts and others showing probable atmospheric origin of the shadow bands, determination of the wave-length of the corona line (λ 5304), and estimates of the varying luminosity during eclipse form the main substance of the paper. C. P. B.

LIGHT.

2152. *Sources of Monochromatic Light.* **C. Fabry** and **A. Pérot.** (Journ. de Physique, 9. pp. 369–382, July, 1900.)—This paper consists of a useful series of descriptions of the various methods used by the authors for obtaining monochromatic lights of varying degrees of purity in their researches on interference measurements. The most useful cases were: (1) simplification of white light by analysis of spectrum; (2) emission spectrum of a gas; (3) flames; (4) gases electrically excited by various sources of power; (5) electric spark; (6) electric arc in air; (7) electric arc in vacuo. The final choice was fixed on a mercury arc in vacuo, using the green line chiefly, the other radiations being suppressed by interpolated solutions of quinine, eosine, &c. C. P. B.

2153. *Photometry oj Arc Lamps.* **F. W. Carter.** (Elect. Rev. 47. pp. 44–45, July 13; 120–121, July 20; 128–129, July 27, and pp. 197–198, Aug. 3, 1900.)—This paper gives details, illustrated by drawings, of a plant for testing arc lamps. A modified form of photometer, termed a "distinctness" photometer, is described in which the observation face of, *e.g.*, the two blocks of paraffin wax in the Joly photometer, is covered with a plate marked with a graduated mesh, and instead of comparing the illuminations the observer seeks the level at which the mesh becomes so fine as to be indistinct, and moves the photometer until this level is the same on both sides of the centre line. The mesh is preferably observed through a telescope whose aperture can be reduced by means of an adjustable diaphragm in order to vary the apparent brightness of the mesh. An apparatus is also described for obtaining the polar curve by comparing the candle-power in one direction, *e.g.*, the horizontal, with those at other angles, this being effected by reflecting the light at the two angles in opposite directions along the photometer bench by means of mirrors. C. K. F.

2154. *Photometer for Mean Spherical Candle-Power.* **R. Ulbricht.** (Elektrotechn. Zeitschr. 21. pp. 595–597, July 19, 1900.)—The principle on which the photometer is based is that in a spherical globe with diffusing surface containing a source of light the illumination due to the diffuse reflected light is uniform throughout the whole surface of the globe, however variable be the intensity of the light in different directions. The mean direct illumination then bears to the uniform illumination, due to the diffused and reflected light, a constant ratio which depends only on the nature of the diffusing surface of the globe. For a diffusing surface formed on glass by a layer of chalk held in a suitable medium, this ratio is about four to one.

The photometer is constructed as follows: a globe of milk glass is covered inside with a layer of chalk and outside with an opaque covering, leaving transparent only a small circular area, the illumination of which is measured by an ordinary photometer. The rays from the lamp in the globe are prevented from falling directly on this area by an opaque white screen with diffusing surface, and only large enough to shade the transparent area. The illumination of the area is then due only to reflected light, and its candle-power as measured by the photometer is equal to the mean spherical candle-power of the lamp within the globe multiplied by a factor which is constant for any one arrangement of globe and screen.

To test how far the truth of the principle on which the photometer is based is borne out in practice the author enclosed in the globe a half-obscured incandescent lamp, and measured its candle-power when giving light in different directions relative to the transparent area on the globe. The results show that the mean spherical candle-power can be determined by one measurement on this photometer with an accuracy well within the limits of error of ordinary photometry. G. H. B.

2155. *Electro-photography.* **F. E. Nipher.** (Elect. Rev. 47. pp. 207–208, Aug. 10, 1900. From a paper in the Transactions of the Academy of Science of St. Louis, vol. x. No. 6.)—Photographic plates are prepared by exposing them to the light of an ordinary room for from one to nine days. The plate is laid on a plate of glass covering a plate of metal connected to one electrode of an influence machine. The coin or medal is connected to the other electrode, preferably through a spark-gap. The exposure is from four to ten minutes. A much longer exposure reverses the picture and gives a positive. The exposure should be in a darkened room, as light counteracts the electrical effect. Development must be carried out in a moderate light, such as that of a single incandescent lamp, and detail can be brought out by carefully varying the distance from the lamp during development. Coins show the lettering and device, and also a halo at some distance from the edge. Ordinary objects may be photographed as positives by exposing the plates to Röntgen rays for several hours and then over-exposing them thirty or forty times. Development can then be carried out in daylight, and very rich effects obtained. The author also describes a method of producing a globe discharge by attaching a ball provided with a needle-point to one of the terminals of the influence machine and bringing the needle-point into contact with the sensitive plate. E. E. F.

2156. *Measurement of Photographic Intensities.* **E. C. Pickering.** (Astrophys. Journ. 11. pp. 416–420, June, 1900; from the Harvard College Observatory Circular, No. 50.)—This is a review of the various methods adopted at the Harvard College Observatory from time to time for the measurement and comparison of photographic light intensities. Since 1887 all the photographs obtained at the Observatory have had the image of a standard light scale impressed upon them for subsequent comparison. The methods now in use have been developed by E. S. King. All sources of light, that of the sun, moon, sky, milky way, aurora, and stars, are in this way to be referred to one standard, given by the meridian photometer, with which the star Polaris has a magnitude of 2·15. The artificial standard for practical convenience is that furnished by an Argand burner behind a small aperture, but this is compared with Polaris every month, when a series of tests are made on an 8 × 10-inch plate, which is then cut up and the various parts stored for future inspection. These monthly comparisons, in addition, furnish a valuable check on the constancy of the plate and the developer used, and will, moreover, as the several parts of the divided plate are developed at different periods, furnish data concerning any change in the impressed image dependent on the interval between exposure and development. Spectroscopic photometry is also adopted to record the photographic intensity in terms of light of a particular wave-length.

In the same paper is also included a description of the method evolved by

W. H. Pickering for reducing the standard of comparison to the actual radiation received from a certain star shining directly on to the sensitive plate. This unit, however, being so small, secondary and tertiary standards have been made from it by using lenses of known aperture and focal length. Thus, with a simple plano-convex lens of 8·2 cm. aperture, the image of α Ursæ Minoris was received on a piece of ground glass placed 3 cm. from the photographic plate. The "*sensitive tint*" was produced after twenty minutes' exposure, and the intensity of the light was calculated to be *thirty* times greater than the direct radiation from the star. For lights of greater intensity this secondary standard is still too small, and then recourse is had to the Argand burner constant. C. P. B.

2157. *Sensitometry of Photographic Plates.* **J. M. Eder.** (Akad. Wiss. Wien, Sitzb. 108. pp. 1407–1498, 1899.)—The author adopts Scheiner's sensitometer, which consists of a disc rotating in front of a dark slide which contains a long narrow plate. An opening is cut in the disc, increasing in width by steps from the periphery to the centre. The plate is thus given exposures increasing in duration by steps from one end to the other, the exposure ratio of successive steps being 1 : 1·27. The source of light was a Scheiner benzene standard of candle-power equal to 0·076 that of the Hefner amylacetate lamp.

For comparisons of the density of silver deposit on plates, a series of plates exposed in the Scheiner sensitometer were calibrated in a Weber photometer, the ratio of the incident to the transmitted light being determined for each gradation. These plates were used as standards to measure the density on any plate in Hartmann's mikrophotometer, in which a single light illuminates the two plates from behind, and two objectives bring the images of the plates together into the field of one eyepiece.

As a measure of sensitiveness of a plate the author proposes the quantity of light necessary to produce the faintest visible image on development. This is claimed to be a more determinate quantity than that adopted by the Paris Congress of 1889, namely, the quantity of light necessary to produce a standard degree of blackening. The fog of a plate, *i.e.*, the blackening produced by development without exposure to light, is a very variable quantity, and vitiates the method of the Paris Congress.

The author exposes the plate in Scheiner's sensitometer behind a metal screen stamped out with the numbers corresponding to the different durations of exposure. The faintest number visible on development by iron oxalate after a definite exposure is taken as a measure of the sensitiveness.

The author confirms Schwarzschild's results [Abstract No. 815 (1900)] that the blackening of a plate is not proportional to the quantity of incident light, but depends also on the intensity of the light, and on whether the exposure is intermittent or continuous. He shows how these variations from Bunsen's reciprocity law may be corrected in determining the sensitiveness of a plate.

A large number of "blackening curves" are given for different plates and different developers, and times of development; the ordinates represent the blackening or the log. of the ratio of incident to transmitted light, and the abscissæ the amount of light incident during exposure. In the lower portion of the curve, corresponding to under-exposure, the blackening is nearly proportional to the quantity of incident light; in the succeeding steeper portion, corresponding to correct exposure, the increase of blackening is nearly proportional to the increase of the log. of the quantity of light; in the last portion the inclination of the curve becomes similar to that of the first portion, and corresponds to over-exposure. Longer development produces greater blackening and steeper curves, corresponding to greater contrast in the plate. The addition of potassium bromide has a marked influence in diminishing fog in the case of iron oxalate developer. Hydroquinone gives a great deal of fog, adurol less, though more than iron oxalate.

The influence of temperature on development is very marked; the blackening and the contrast of the plates both increase with the temperature. Intensification, especially with mercury and ammonia, increases the contrast. Reduction by prussiate of potash alters but slightly the contrasts, but they are weakened by ammonium persulphate. Blackening curves and curves of sensitiveness are given for lights of different wave-lengths, and the effects of erythrosin, eosin and Congo-red are examined in detail.

The author compares his results with those of Hurter and Driffield, criticising the latter's system of sensitometry and their "development constant." G. H. B.

2158. *Zeeman Phenomenon.* **H. M. Reese.** (Elect. World and Engineer, 36. pp. 248–249, Aug. 18, 1900. Abstract of paper read before the N.Y. meeting of the American Physical Association and the A.A.A.S.)—To determine whether the separation was strictly proportional to the strength of the field, a number of photographs were taken of the same lines with fields ranging from 6,000 to 27,000 c.g.s. units. Zinc and cadmium lines were tested together, the spark-gap having terminals of cadmium and zinc respectively. These and the corresponding magnesium lines offer unusually wide separation and a considerable variety of complexity. In the case of the sharp triplets the proportionality between field intensity and separation is very nearly exact. The sextuplets show a separation which increases less rapidly with the field when the latter becomes very intense, and in the "diffuse triplets" this tendency is much more marked. At the same time the shading towards the red is considerably reduced, and all the lines become sharper. The author has not been able to verify all the cases of asymmetry noted by Zeeman. He has, for instance, observed no lines in which the violet component is the stronger. But in all cases where asymmetry was observed the author found that it disappeared on increasing the field strength, as Voigt's theory indicates. E. E. F.

2159. *Spectra of Oscillating Discharges.* **G. A. Hemsalech.** (Journ. de Physique, 9. pp. 437–444, Aug., 1900.)—The author, in continuation of his previous work [see Abstracts Nos. 1428 and 1651 (1900)], has provided a much more powerful spectroscope for the photography of spectra. Reproductions are given of twelve spectra, showing the gradual changes produced in the spectrum of an ordinary induction spark by introducing self-induction into the secondary circuit. With regard to possible work by Thalén in this respect, he shows that the presence of an iron core in the self-induction coil destroys the oscillations almost completely, and therefore the effects observed by Thalén with an electromagnet having an iron core could not have been identical with those now described. C. P. B.

2160. *Spectrum of Radium.* **C. Runge.** (Ann. d. Physik, 2. 4. pp. 742–745, Aug., 1900.)—The author criticises the fifteen spectrum lines ascribed by Demarçay to radium [see Abstract No. 55, (1900)]. He points out that the accuracy with which these fifteen lines were determined is not very great, the error being about 0·7 of an Angström unit. Hence Demarçay's line 4683·0 might be anywhere between 4682·3 and 4683·7. But in this interval there are no less than six Fraunhofer lines, according to Rowland, and that makes the evidence for the separate identity of radium much feebler than it was. The author has therefore redetermined the spectrum of radio-active barium chloride with a greater dispersive power than that employed by Demarçay, and has definitely located three of Demarçay's lines. These are situated at 4826·14, 4682·346, and 3814·591 respectively. The remainder were either invisible or were found in the spectrum of barium chloride when free from radium. An economical method of obtaining the spectrum was that of dipping a thin platinum wire into the powdered preparation and heating the wire by means of an electric current until a bead was formed, which was then made an anode in a spark-gap. But it is possible that the luminous intensity attained was not great enough to reveal some of the feebler lines described by Demarçay. But the three lines mentioned above are definitely established, and they are not contained in the solar spectrum. E. E. F.

2161. *New Spectra of the Rare Earths.* **E. Demarçay.** (Comptes Rendus, 131. pp. 387–389, Aug. 6, 1900.)—Pure terbium peroxide is much darker than has been supposed; the author has obtained a specimen nearly black. In purifying the double nitrate of gadolinium and magnesium, he has prepared from the mother liquors a dark brown peroxide yielding spark lines which appear peculiar to terbium, and are also found in terbias from other sources. Three separate groups of rays obtained from other fractionations he considers due to three new elements; the measurements are given. S. R.

2162. *Spectra of Mixtures.* **C. J. Rollefson.** (Phys. Rev. 11. pp. 101–104, Aug., 1900.)—A photographic study by means of a modified Foley's apparatus, which is figured, of the effect on the spectrum of a metal of the introduction of the salt of another metal into the arc. In some cases the lines are widened and altered in intensity. S. R.

2163. *Absorption Spectra of Ammonia, Methylamine, Hydroxylamine, Acetaldoxime and Acetoxime.* **W. N. Hartley** and **J. J. Dobbie.** (Chem. Soc., Journ. 77. and 78. pp. 318–327, April, 1900.)—Even after many recrystallisations as ammonium sulphate, ammonia still shows a dark band in its absorption spectrum. The authors find, however, that no selective absorption is shown by ammonia obtained from the reduction of hydroxylamine or from ammonium oxalate purified by crystallisation. The addition of pyridine causes the reappearance of the absorption band. The absorption spectra of methylamine, hydroxylamine, acetaldoxime and acetoxime in solutions of various concentrations are also given. T. H. P.

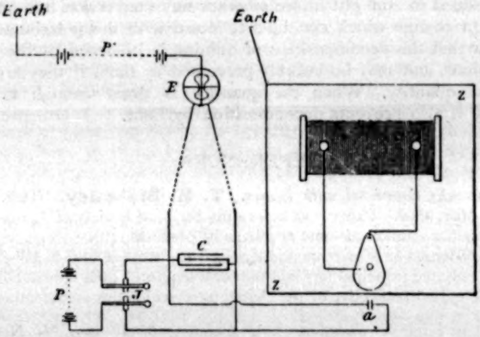
2164. *Absorption Spectra of the Ethyl Dibenzoylsuccinates.* **W. N. Hartley** and **J. J. Dobbie.** (Chem. Soc., Journ. 77. and 78. pp. 498–509, April, 1900.)—The absorption spectra of the ethyl α-, β-, and γ-dibenzoylsuccinates are given. The curves for the β- and γ-compounds are identical and differ considerably from that of the α- or enolic ester. These results are in accord with the structural formulæ arrived at by Knorr (Annalen, 1896, 293, p. 70) on purely chemical grounds. T. H. P.

2165. *Absorption Spectra of Benzantialdoxime and Benzsynaldoxime.* **W. N. Hartley** and **J. J. Dobbie.** (Chem. Soc., Journ. 77. and 78. pp. 509–512, April, 1900.)—The absorption spectra of benz-antialdoxime and -synaldoxime are found to be identical; the conclusion previously arrived at that stereoisomerides, unlike isomerides differing in structure, give identical absorption spectra, is thus borne out. T. H. P.

2166. *Uranium Rays.* **H. Becquerel.** (Comptes Rendus, 131. pp. 137–138, July 16, 1900.)—When uranium chloride is mixed with barium chloride, and the barium is precipitated as sulphate, the latter takes down with it the greater part of the radio-activity of the uranium. The question remains as to whether a further application of the same process would eventually result in the uranium being made entirely inactive. The author has therefore applied the same process eighteen times over to the same specimen. He found that the barium sulphate precipitated was less and less active, and that correspondingly the loss of activity of the uranium became less and less in proportion to its initial activity. Between the eighth and twelfth operation the variations in activity were sometimes positive and sometimes negative, and could possibly be due to the presence of more or less water, as the salt is hygroscopic. In the case of the unpurified product, aluminium is more transparent for the rays than glass, but the case is reversed in the purified uranium, whose rays obey rather the rules of light than those of Röntgen rays in the matter of absorption. After the fifteenth operation another decided diminution of activity sets in, bringing it down to one-sixth of the original activity. What happens after the eighteenth operation is not yet known.

E. E. F.

2167. *Discharge of a Condenser by Röntgen Rays.* **F. Campanile** and **G. di Ciomme.** (Phys. Zeitschr. 1. pp. 401–407, June 23, 1900.)—In the accompanying diagram, C represents an Elliott microfarad condenser, charged by a battery P of 40 small Daniell cells, and discharged through a gap *a* between copper points or discs. E is an electrometer charged by 100 volta elements P′, and Z is a metallic box containing the whole apparatus for generating Röntgen rays, and put to earth. It was found that at all potentials the discharge is accelerated by the Röntgen rays. Although the quantities discharged by the Röntgen rays become smaller as the potential decreases, the rays are comparatively more effective at the lower than at the higher potentials. The capacity of the condenser has a marked influence upon the quantity discharged. The quantity is great in the case of small capacities, decreases to a minimum with increasing capacity, and then increases again.



E. E. F.

2168. *Radio-activity in Barium Salts.* **A. Debierne.** (Comptes Rendus, 131. pp. 333–335, July 30, 1900.)—Actinium is employed in producing radioactivity which happens to be but feeble in barium salts. The induced activity, as with radium and thorium, depends on the nearness and duration of action of the inducing substance. Intimate contact is secured by putting the substance to be rendered active in solution with the active body or by precipitating the two together. It is found that the artificially radio-active barium and radiferous barium extracted from pitch blend have some common properties: the radio-activity persists through chemical transformations; the rays from both substances ionise gases, excite phosphorescence in Ba Pt Cy., and affect photographic plates. Further, a part of the radiation is deviated in the magnetic field, and the anhydrous chloride is luminescent. On the other hand, the "activated" barium does not give the radium spectrum, and its activity diminishes with time. G. E. A.

2169. *Fluorescence of Quinine.* **G. C. Schmidt.** (Phys. Zeitschr. 1. pp. 466–467, July 28, 1900.)—It was pointed out by Stokes that the fluorescence of quinine is destroyed by hydrochloric, hydrobromic, and hydriodic acids, and by salts of these acids. After investigating this behaviour E. Buckingham came to the conclusion that only the quinine-ions were able to fluoresce, and that the fluorescence was destroyed by hologen-ions from any source. From experiments on the absorption-spectrum of quinine sulphate before and after adding haloid salts, the author concludes that the hologen-ions do not produce any chemical changes in the quinine. As they destroy the fluorescence of quinine it seemed desirable to examine whether they reduce its chemical reactivity. To test this, quinine sulphate was dissolved with addition of sulphuric acid and known quantities of haloid salts; the solution was then placed in sunlight to see whether any conversion into cinchonine took place (a change which could be followed with the polarimeter). The results show that the decomposition of quinine is hindered by the presence of halogen-ions, and may be entirely prevented by them if they are present in sufficient quantity. When the quantity is great enough to prevent fluorescence it also prevents decomposition by light. D. E. J.

REFERENCES.

2170. *Formulæ Connected with Lenses.* **T. H. Blakesley.** (Phil. Mag. 49. pp. 447–453, May, 1900. Paper read before the Physical Society of London.)—This paper contains the solution of some problems in practical optics connected with the combination of lenses or of mirrors and lenses. The method used is Abbé's familiar one of using only the principal foci and the focal length of each optical combination in the system, quite irrespective of the elements of which the combinations may be built up. J. B. H.

2171. *Binocular Magnifying-Glass.* **E. Berger.** (Zeitschr. Instrumentenk., Beib. pp. 53–56, March 15, 1900.)—This paper deals with the theory of the binocular magnifying-glass described in Abstract No. 620 (1900). J. B. H.

2172. *Uranium, Radium, and Metallic Emissions.* **G. le Bon.** (Revue Scientif. 13. pp. 548–552, May 5, 1900.)—The announcement by the author some years ago, that metals in certain conditions emit radiations, is claimed as having begun the study of radio-active bodies. As uranium rays in common with other metallic rays are not polarised, and as chemical analysis does not prove the existence of new bodies, the author disputes the existence of radium and polonium, and explains radio-activity as the emission of dissociated atoms. G. E. A.

2173. *Colour Perception.* **W. Heinrich.** (Acad. Sci. Cracovie, Bull. pp. 64–92, Feb., 1900.)—A critical and historical review of the methods of investigation of colour perception. G. E. A.

2174. *Lummer-Brodhun Photometer.* **O. Lummer** and **E. Brodhun.** (Phil. Mag. 49. pp. 541–543, June, 1900.)—Reply to the paper by C. G. Knott referred to in Abstract No. 481 (1900).

2175. *Formulæ for Lenses.* **B. Wanach.** (Zeitschr. Instrumentenk. 20. pp. 161–171, June, 1900.)—This paper contains the development of formulæ for calculating the path of rays of light through a centric system of lenses. The formulæ are also applied to the case of a photographic objective. J. B. H.

2176. *Atmospheric Refraction.* **A. Gleichen.** (Deutsch. Phys. Gesell., Verh. 2. 2. pp. 24–36, 1900.)—This paper contains a mathematical study of the refraction which a pencil of rays emanating from a point outside the atmosphere suffers on passing through the atmosphere. The positions of the primary and secondary focal surfaces are investigated and applied to the case of lunar eclipses to account for the illumination of the moon's surface during eclipse. J. B. H.

2177. *Wave Theory of Light.* **A. Cornu.** (Cambridge Phil. Soc., Trans. 18. pp. 17–28, April, 1900. Rede Lecture.)—The lecturer sketches the development of the wave theory from the time of Descartes to the present day, and dwells upon the profound influence which this theory, and optics generally, have exerted upon the progress of physics. E. E. F.

2178. *Spectral Apparatus.* **H. Lehmann.** (Zeitschr. Instrumentenk. 20. pp. 193–204, July, 1900.)—This paper contains a description of the different methods of using the grating spectral apparatus in which the telescope, or camera, and the collimator remain fixed, while the grating is rotated. The greater part of the paper is devoted to a mathematical study of the dispersion obtained in different arrangements, and the publication is intended to form a guide in the use of the apparatus of this type made by Steinheil. J. B. H.

2179. *Grating Films and Colour Photography.* **T. Thorp.** (Manchester Lit. and Phil. Soc., Mem. 44. 12. pp. 1–8, 1900.)—An account is given of the preparation of celluloid casts from a Rowland metal diffraction grating and the application of these to photography in colours. J. J. S.

2180. *Becquerel Rays.* **H. Starke.** (Zeitschr. Instrumentenk. 20. pp. 212–220, July, 1900.)—An historical *résumé* and an enumeration of the chief properties of the rays, with some reference to the emission theory. G. E. A.

2181. *Refraction and Magnetic Rotation of Hexamethylene and of Chloro- and Dichloro-Hexamethylene.* **S. Young** and **E. C. Fortey.** (Chem. Soc., Journ. 77. and 78. pp. 372–374, April, 1900.)—The results of redeterminations of these constants by W. H. Perkin, sen., are given. T. H. P.

HEAT.

2182. *Relation of Specific Heats of Metals to their Atomic Weights.* **W. A. Tilden**, with Appendix by **J. Perry.** (Roy. Soc., Proc. 66. pp. 244–247, April 14, 1900; Roy. Soc., Phil. Trans. 194. pp. 233–255, June 6, 1900.)—Results are given of the measurement of the specific heats of specially purified nickel and cobalt by means of Joly's steam calorimeter. The mean specific heat of cobalt between 15° and 100° is 0·10303, the value for nickel being 0·10842. Taking 55·55 and 58·24 for the respective atomic weights, the numbers for the atomic heats become 6·03 and 6·31, so that Dulong and Petit's law cannot be taken as strictly applicable at all temperatures. Gold and platinum represent another pair of metals with nearly equal atomic weights and densities; the specific heats (between 15° and 100°) are 0·03035 and 0·03147 respectively, so that the atomic heats have very different values. Determinations of the specific heats of several impure samples of iron and copper show that the specific heat of a metal is raised appreciably by the presence of small quantities of a non-metallic impurity, whilst the presence of a second metal produces very little effect on the specific heat until the quantity of it is large enough to be felt through the difference of atomic weight. The specific heat of pure copper is 0·9232 and that of iron 0·10983 for the limits of temperature 15° and 100°. Calorimetric measurements made by the method of mixtures on pure nickel and cobalt at low temperatures show that as the temperature falls the specific heat of nickel diminishes more rapidly than that of cobalt, the two values gradually becoming more and more nearly equal. The following table gives the mean specific heats for the different ranges of temperature :—

Temperature.	Cobalt.	Nickel.
From 100° to 15°	0·10303	0·10842
„ 15° to — 78·4°	0·0939	0·0975
„ 15° to — 182·4° ...	0·0822	0·0838
„ — 78·4 to — 182·4°	0·0712	0·0719

The atomic heat at — 273° C. is for both metals about 4, and it is probable that at this temperature the specific heats would be inversely proportional to their atomic weights. The variations of the specific heats of nickel and cobalt with the temperature are expressed with good agreement by the following formula, deduced by Perry :—

$$K = k_0 \left(1 + \frac{bt^n}{c + t^n}\right)$$

where K is the specific heat, t the temperature on the absolute scale, and k_0, b, c, and n constants, which for cobalt have the values 0·0412, 1·695, $1·002 \times 10^6$, and 2·73 respectively, whilst in the case of nickel the numbers are 0·0415, 1·892, $0·932 \times 10^6$, and 2·68 respectively. T. H. P.

2183. *Boiling-points of Zinc and Cadmium.* **D. Berthelot.** (Comptes Rendus, 131. pp. 380–382, Aug. 6, 1900.)—An interference method, described in 1895, is used. The mean of five determinations for pure zinc gives 920°. The mean of three for cadmium is 778°. Previous results are mentioned.

G. E. A.

2184. *Electric Pyrometers.* **J. A. Montpellier.** (Électricien, 20. pp. 97–100, Aug. 18, 1900.)—This paper is a description of the electric pyrometers for high and low temperature, exhibited by Hartmann and Braun at the Paris Exhibition. For temperatures up to 400° C. the change of resistance in a wire spiral is measured by an ohmmeter reading direct in degrees Centigrade. For temperatures from 400° to 1,600° C. a thermocouple is used with a millivoltmeter. The couple used for temperatures from 400° to 1,000° C. is platinum and an alloy of platinum and nickel, and for temperatures from 1,000° to 1,600° C., platinum and an alloy of platinum containing 10 per cent. rhodium. The construction of the pyrometer is new; it consists of a number of short cylinders of refractory material held together end to end by a central metal rod. The thermocouple wires pass through longitudinal holes in the cylinders. It is claimed that the cylinders remain in place even though one or more may crack. G. H. B.

2185. *The Determination of γ by Observations on the Dew-point.* **R. Cozza.** (Archives des Sciences, 10. pp. 132–143, Aug., 1900.)—The author used a metal cylinder, closed at each end by glass plates, in which to conduct the compression of the moist gas so that the deposition of moisture in the gas could be easily perceived when the dew-point was reached. The cylinder had three tubes leading from it—one to a pump, a second to a manometer for registering the pressure, and a third, closed by a stopcock, by which the cylinder could be placed in communication with the outer air. A thermometer outside the cylinder completed the apparatus. To conduct an experiment the cylinder is filled with air, and by means of the pump this air is compressed, and when the heat produced by the compression has been dissipated, the stopcock leading to the open air is opened suddenly, and the consequent expansion causes a cooling of the air. If this cooling be sufficient the dew-point is reached and a cloud is seen in the cylinder. Observations are made with gradually decreasing amount of compression until that point is reached when only the faintest cloud is visible on opening the stopcock.

Using the formula—

$$T_2 = T_1\left(\frac{p_2}{p_1}\right)^{\frac{C-c}{C}}$$

where—

T_1 = initial temperature,
p_1 = pressure before opening stopcock,
p_2 = pressure of external air,
T_2 = dew-point,

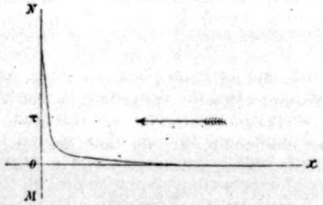
the value of $\frac{C-c}{C}$ can evidently be obtained.

In two methods employed the following results were obtained :—

			T_2		γ	
p_2.	p_1.	T_1.	1st method.	2nd method.	from 1st.	from 2nd.
729	962	295	272·5	274·0	1·400	1·363
722	933	295	272·5	274·0	1·447	1·405
726	916	295·4	273·0	274·3	1·512	1·467
703	916	294·5	272·0	273·6	1·427	1·389
706	904	294·0	271·5	273·0	1·473	1·426

W. C. O.

2186. *Temperature Gradient in Flames.* **H. Mache.** (Akad. Wiss. Wien, Sitzb. 108. pp. 1152–1160, 1899.)—This is a physical investigation of the temperature gradient in a homogeneous burning mixture of gases, such as a detonating mixture of oxygen and hydrogen. If such a mixture is contained in a tube, and an explosion started at one end, the explosion travels along the tube with a definite velocity. The surface separating the exploded from the unexploded portion is the "burning surface." On one side of this surface the gases have the temperature of combustion, on the other they have the temperature of ignition. The transition from the one to the other is abrupt, being distributed over a distance of molecular dimensions. When the gases issue from an orifice, the velocity with which they issue is opposed to the velocity of propagation of the burning surface, and the latter becomes stationary. To determine the distribution of temperature, the author considers the burning surface MN (see diagram), against which the gases stream in the direction of the arrow, with a velocity equal to the velocity of explosion c. By the time the gas reaches MN it has been heated up to the ignition temperature τ by conduction from the gases burning at a temperature T. There must be a definite gradient of temperature along x. For $x=$ inf., the temperature U is the initial temperature t of the mixture. For $x=0$, $U=\tau$. Let two adjacent strata have the temperatures U and $U+dU$. If k is the conductivity, then $-k\frac{\partial U}{\partial x}$ is the amount of heat passing unit surface in unit time. Of that amount $k\frac{\partial^2 U}{\partial x^2}$ remains behind in unit volume. Now, if the temperature is to be stationary, the gas of temperature U must be so often renewed by the gas of temperature $U+dU$ that the quantity of heat $k\frac{\partial^2 U}{\partial x^2}dx$ just suffices to bring the incoming gas up to a temperature U. If ρ is the density, and C the specific heat at constant volume of the gas, and the layer must be renewed n times in unit of time, we have—



$$-n\,dx\,\rho C\,dU = k\frac{\partial^2 U}{\partial x^2}dx.$$

The author works out a solution of this equation, and shows that the temperature decreases rapidly upwards from the burning surface, being 600° at 12 cm. distance from it, 200° at 65 cm., and 50° at 122 cm. He also shows how to investigate the thickness of the exploding layer. He determines the amount of heat which would pass it if the ignition layer and the layer of complete combustion immediately joined each other, and shows that that quantity is of the same order as that which actually passes, and not very different numerically. For hydrogen the coefficient of this abrupt change of temperature is–

$$\gamma = \frac{(T-\tau)k}{c_0\rho_0\gamma_0\tau} = 0{\cdot}002.$$

E. E. F.

2187. *Saturation Curve of Carbonic Acid.* **E. H. Amagat.** (Comptes Rendus, 131. pp. 91–92, July 9, 1900.)—In his studies on carbonic acid made in 1892, the author found that the diameter of the curve of liquid and vapour densities at saturation was a straight line, and also that the locus of the points for which the volumes of the liquid and the vapour are equal was a straight line. Mathias, on the other hand [see Abstract No. 1441 (1900)], found that this locus was not a straight line, but a curve which very nearly coincided with its tangent at the critical point. The two loci in question having been constructed with the same experimental material, there is no reason to suppose that the one is more real than the other. Both may be practically rectilinear, but they cannot both be mathematically so. The law discovered by Cailletet and Mathias is useful in all researches concerning critical constants, and the author has himself obtained some figures which show that for a certain number of substances and between wide limits of temperature the diameter is practically a straight line, but it is clear that bodies are known for which the diameter in question is curvilinear. E. E. F.

2188. *Maximum Pressure of Camphor Vapour.* **R. W. Allen.** (Chem. Soc., Journ. 77. and 78. pp. 413–416, April, 1900.)—The vapour pressures of camphor, determined by the two methods described in the following Abstract, are given. The values obtained in the two cases are concordant, those given by the evaporation method being as follows :—

Temperature.	Vapour Pressure.
15·6°	0·14 mm. mercury.
35·0°	0·33 „
45·0°	0·91 „
49·0°	1·23 „
75·0°	6·59 „

These numbers differ considerably from those of Ramsay and Young (Phil. Trans., 1884, i. p. 45). T. H. P.

2189. *Maximum Pressure of Naphthalene Vapour.* **R. W. Allen.** (Chem. Soc., Journ. 77. and 78. pp. 400–412, April, 1900.)—The author gives the results of measurements of the vapour pressure of naphthalene at various temperatures, the methods employed being (1) the ordinary barometric method, and (2) the evaporation method, in which a known volume of an indifferent gas at a definite temperature is passed over a weighed quantity of the naphthalene, the loss of which is determined at the end of the experiment. The values obtained by method (2) are—

Temperature.	Vapour Pressure.
15°	0·066 mm. mercury.
30°	0·135 „
45°	0·51 „
60°	1·81 „
75°	5·43 „

The first method gives numbers agreeing well with the above, the values for other temperatures being—

Temperature.	Vapour Pressure.
0°	0·01 mm. mercury.
78·4°	7·01 „
80·4°	7·54 „
100°	18·50 „
116°	36·87 „
130°	61·95 „

T. H. P.

2190. *Vapour-pressure, Heat of Vaporisation and Triple Points of Bromine and Iodine.* **K. Tsuruta.** (Phys. Zeitschr. 1. pp. 417–419, June 30, 1900.)—By interpolation a table of vapour pressures for bromine between — 16° and 55°, and for iodine from 60° to 180°, has been obtained. The heat of vaporisation of bromine at the boiling-point is calculated from Clausius' formula to be 45·3, whilst the mean experimental value is 44·9 cal. The melting-point is calculated to alter 1° C. for each 49·20 atmospheres in the case of bromine, and for each 31·78 atmospheres in the case of iodine. T. M. L.

2191. *Law of Corresponding States.* **D. Berthelot.** (Comptes Rendus, 131. pp. 175–178, July 16, 1900.)—The suggestion has often been made that this law would be more exact if temperatures and specific volumes were measured from special "zeros," which differ for different bodies, but are not 0. For the bodies studied by S. Young the author finds the following special zeros, those for temperatures being expressed in degrees C., and those for specific volumes in cc. per grm. :—

	t_m	v_m		t_m	v_m
C_6H_6	46·6	0·892	CCl_4............	40	0·490
C_6H_5Fl	56	0·767	Ether	51·4	1·019
C_6H_5Cl	61	0·734	CO_2	21	0·599
C_6H_5Br.........	69	0·554	Pentane	46	1·171
C_6H_5I	72	0·459	Isopentane...	43·3	1·179

These are confirmed by comparison with Mme. K. Meyer's results [see Abstract No. 1049 (1900)]. R. E. B.

2192. *Molecular Theory of Gases.* **M. Brillouin.** (Annal. Chim. Phys. 20. pp. 440–485, Aug., 1900.)—This is a study by Maxwell's 1879 method, but without the assumption that the force acting between molecules during an encounter varies inversely as the fifth power of their separation. Taking the distribution of speeds to be $\phi(1 + \zeta)$, where ϕ is Maxwell's distribution for the case of equilibrium, and ζ is a complementary factor due to the flow of the gas and the propagation of heat in it, the author finds that ζ is directly affected by the external field of force, which has consequently a direct effect upon the viscosity, thermal conductivity, &c., of the gas, the exact nature of which depends on the law of action between molecules ; and he thinks that the terms depending upon density that his analysis has introduced have an important place in the theory of flame in determining the region separating combustion from explosion. R. E. B.

2193. *Adiabatic Expansion of Wet Steam.* **F. W. Arnold.** (Inst. Civ. Engin., Proc. 140. pp. 221–225, June, 1900.)—It is known that the law $pv^{\gamma} = c$ does not hold for the adiabatic expansion of wet steam ; it is, however, nearly true in many cases, the value of γ depending upon the range of initial temperature and initial dryness. The author found it necessary to find the value of γ for steam of various drynesses and temperatures, usually over a range of 80° C. For each mean temperature a curve was plotted with the initial drynesses as abscissæ, and the corresponding values of γ as ordinates ; another set of curves was drawn, one for each initial dryness, with the mean temperatures as abscissæ and corresponding values of γ as ordinates. The following expression is obtained, which holds within 1 per cent. if the mean temperature θ lies between 80° and 180° C., and the initial dryness x_1 is greater than 0·2—

$$\gamma = 1{\cdot}125 + \frac{2\theta + 140}{2000}\left(\frac{0{\cdot}0323}{x_1^2} - \frac{0{\cdot}449}{x_1} + 0{\cdot}459\right)$$

No attempt is made to give an equation showing the variation of γ, taking into account all the intricacies. A. S.

2194. *Problem in the Theory of Heat, proposed by F. Kohlrausch.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math-Phys. Klasse, 3. pp. 228–239, 1899.)—Kohlrausch, in a work "on the stationary temperature of a conductor heated by the electric current" (Berlin Berichte, xxxviii. p. 711, 1899), treats the problem of a conductor on whose surface two regions are maintained at different constant temperatures and potentials, the rest of the surface being isolated for heat and electricity. The author gives a solution of the problem, taking into consideration the "Thomson effect" of which Kohlrausch had not taken account. The solution is founded on the author's own former works (Gött. Nachr., 1895, p. 135; 1898, p. 113; Wied. Ann. 67. p. 717), the present problem offering an example of his methods. If T denote the absolute temperature, Θ a function of T depending on the nature of the substance, Δ the conductivity for heat, λ that for electricity, we have—

A thermoelectric component of force, $X = \dfrac{\partial\Theta}{\partial x} = \dfrac{d\Theta}{dT}\dfrac{\partial T}{\partial x}$ (1)

A component electric current, $u = -\lambda\,\dfrac{\partial(\Phi - \Theta)}{\partial x}$ (2)

A component current of heat, $U = -\Delta\,\dfrac{\partial T}{\partial x}$ (3)

And a convection current of heat attendant on the electric current, $U = -uT\,\dfrac{d\Theta}{dT}$ (4)

These are the fundamental equations of the theory. S. H. B.

SOUND.

2195. *Propagation of Sound.* **A. W. Duff.** (Phys. Rev. 11. pp. 65–74, Aug., 1900.)—In 1898 [see Abstract No. 777 (1898)] the author described a method of determining the attenuation of sound with distance which was based upon the employment of a number of whistles of equal loudness, and the distance at which a certain number of them became inaudible. To test the rapid decay of intensity then found, the author has since employed another method, consisting in the comparison of the intensity of a whistle at a certain distance with the intensity of the same sound as transmitted by a telephone. Points were found at which both were equal. A whistle of pitch 4,000 was found most suitable, as small differences of quality were less disturbing at that pitch. Within the limits of error the following theoretical laws for the intensity S were verified :—

For small distances r—

$$S = \frac{1}{r^2}\left(1 + \frac{a^2}{n^2 r^2}\right)$$

For large distances—

$$S = \frac{e^{-2mr}}{r^2}$$

where a is the velocity of sound, n the pitch, and m the sum of three terms involving the viscosity, thermal conduction, and radiation respectively of the medium. The value of m found is 0·000033. E. E. F.

2196. *Production of Sound in Organ-Pipes.* **V. Hensen.** (Ann. d. Physik, 2. 4. pp. 719–741, Aug., 1900.)—In a sounding organ-pipe the air is carried upwards by the inner secondary current within the pipe. A kind of air-sheet is formed next the tongue of the pipe, and the air is exhausted near the mouth. This exhaustion forces the air blown into the pipe to return to the mouth, even if the pipe is open at the top. In doing so the returning air throws the air-sheet into periodic motion. The air-sheet behaves like an incompressible fluid. This theory is illustrated by various experiments with flames and air-blasts. E. E. F.

2197. *The Graphophone Grand.* (Frank. Inst., Journ. 150. pp. 17–34. Supplement by **P. Mauro**, pp. 35–43, July, 1900.)—The graphophone grand is a modification of the graphophone of Bell and Tainter. In the latter instrument the records are scratched upon a revolving cylinder of paper coated with a specially prepared wax by means of a sharp style, the vibrations of the style taking place radially to the surface of the cylinder, so that the result is a spiral groove of varying depth, while the style is so arranged that at no time does it leave the surface of the wax, and thus removes a continuous ribbon of its substance.

The chief modifications which have been introduced in the instrument of Macdonald are :—

(1) An increase in the velocity with which the style is made to pass over the recording surface, thereby ensuring undulations of a greater amplitude with long, gentle, easy strokes, as distinguished from the records of the same sound having short, abrupt undulations. (2) The style is set at a more acute

angle to the recording surface. (8) The diameter of the cylinder is made greater for the reason that the higher speed can be more easily obtained in this way than by an increased angular velocity. The surface velocity is increased two and a half or three times, and the effect that this will produce upon the working of the instrument may be considered thus :—

The cutting style performs its pendulous motions and cuts in the wax a line composed of alternate elevations and depressions. As the cutting edge begins to descend it at first encounters practically no resistance, the sharp edge only being in contact with the material of the tablet, but as the movement continues the crest just being formed comes in contact with the shank of the style, and a check is imposed upon the further penetration of the instrument.

If the surface velocity be high, the slopes are more gentle, and the crests of the undulations as they are formed are carried away so quickly that they do not come in contact with the shank, and thus no check being received the style is enabled to penetrate more deeply, and the amplitude of the vibrations recorded on the tablet is greater.

The greater velocity entails more wax being cut away in a given time, and hence more work being done, but this is overcome by giving the style a sharper angle of incidence upon the wax and a keener edge. With the low-speed records the crests, when close together, did not afford the point of the reproducing style opportunity of descending fully into the intervening depressions ; moreover, when an abrupt ascending slope impinged against the reproducing point the style was thrown off the record, and an interruption of the tracing operation ensued. W. C. O.

2198. *Flutings in the Kundt Sound Tube.* **S. R. Cook.** (Amer. Assoc., Proc. 48. pp. 121–122, 1899.)—The author performed experiments with the object of verifying König's equations for the forces acting to produce flutings in the sound tube. Various materials were tried as fluting substances—magnesium carbonate, lycopodium, amorphous silica, cork dust, magnesium, anthracene, ammonium-chloride fumes, sand, aluminium, iron, brass, copper, coin silver, &c.—the laminæ being examined by the microscope. The equations when worked out give repulsion parallel to the stream lines and attraction perpendicular to the same. In experiments with air and carbon dioxide, when the forces of attraction in the two were made equal, and also the forces of repulsion, the ratio of the densities varied from 0·42 for magnesium carbonate to 0·82 for sand. The ratio of the density of hydrogen to air for the same effect was 5·85. W. C. O.

ELECTRICITY.

THEORY AND ELECTROSTATICS.

2199. *Kinetic Theory of Metallic Conduction.* **M. Reinganum.** (Ann. d. Physik, 2. 2. pp. 398–403, June, 1900.)—The ratio of the thermal and electrical conductivities of a metal may be approximately calculated by Drude's electron theory [see Abstract No. 1276 (1900)], which involves the number of gaseous molecules per gramme and Thomson's value of the elementary electric charge. The author points out that these two numbers, both somewhat roughly determined, are not really necessary at all, and that the much better known values of the electrochemical equivalent and the velocity of hydrogen atoms in a gas may be substituted for them. This substitution gives for the ratio of thermal to electric conductivity the number $0{\cdot}7099 \times 10^{-10}$, which is in remarkably close agreement with the experimental values found by Jäger and Diesselhorst, such as $0{\cdot}706 \times 10^{-10}$ for aluminium. In this agreement the author sees a proof that in metals also, as in liquids, electricity moves in separate quantities of the same value as the quantities transported by electrolytic ions, and that the principles of the kinetic theory of gases apply to both.
E. E. F.

2200. *Thermal and Electric Conductivities.* **E. Riecke.** (Ann. d. Physik, 2. 4. pp. 835–842, August, 1900.)—Comparing his own formula for this ratio with that of Drude [see Abstract No. 1276 (1900)] the author finds that it differs in the numerical factor, which is $\frac{4}{3}$ in Drude's equation and $\frac{3}{2}$ in his own. The difference is probably due to the circumstance that Drude admits the possibility of collisions between the electrons themselves. Following Drude with regard to the kinetic energy of the ions, the ratio of the thermal and electric conductivities becomes—

$$\frac{k}{\gamma} = \frac{3}{2}\,\frac{a^2v^2}{\epsilon^2}\,\mathrm{T}(1 + \tfrac{2}{3}\partial'\mathrm{T}).$$

The kinetic theory of gases gives—

$$a = \tfrac{3}{2}\mu\mathrm{R}.$$

Hence—

$$\frac{k}{\gamma} = \frac{27}{8}\,\frac{\mu^2\mathrm{R}^2v^2}{\epsilon^2}\,\mathrm{T}(1 + \tfrac{2}{3}\,\partial'\mathrm{T}).$$

If $\mu\mathrm{R}$ is a universal constant, and the elementary quantity of electricity ϵ is the same for all monovalent ions, the value of $\mu^2\mathrm{R}^2v^2/\epsilon^2$ may be found by substituting the values as known for hydrogen. This gives—

$$\frac{k}{\gamma} = 9{\cdot}00276 \times 10^{-10} \times v^2\,\mathrm{T}(1 + \tfrac{2}{3}\,\partial'\mathrm{T}).$$

The values obtained from Jaeger and Diesselhorst's experiments on copper are somewhat smaller than the calculated values. E. E. F.

2201. *Electrification by Ice.* **H. Ebert** and **B. A. Hoffmann.** (Ann. d. Physik, 2. 4. pp. 706–718, August, 1900. From the Sitzb. d. k. Bayr. Akad. d. Wissensch.)—In the course of some experiments on liquid air, the authors noticed that a body suspended above the surface of the liquid required a strong negative charge. A series of test experiments revealed the fact that this charge is not due to the liquid air itself, but to the friction of minute particles of very cold ice suspended in its vapour. The authors even succeeded in constructing a kind of electrifying machine by means of a tube containing a piece of wire gauze through which the vapour of liquid air was driven. This phenomenon of electrification should be allowed for in all experiments with liquid air, as it may account for errors and anomalies. Ice acquires a positive charge by friction with any metal, and imparts to the metal, and to other bodies also, a negative charge. It appears to be the more active, in this respect, the colder and drier it is. This may account for the strong electric effects of polar snowstorms. Even in our latitudes, ascending currents of air soon reach elevations at which all their water freezes, and the friction of the ice crystals against suspended dust particles would account for part of the atmospheric electrification. In the highest regions, a friction between atmospheric ice and cosmic dust, together with solar ionisation and the consequent conductivity of the atmosphere, might account for atmospheric luminescence, and even for the aurora. E. E. F.

DISCHARGE AND OSCILLATIONS.

2202. *Electric Discharge in Gases.* **J. Stark.** (Phys. Zeitschr. 1. pp. 439–442, July 14, 1900.)—In gases conveying an electric discharge, the conductivity varies from point to point, according to the number of ions per unit volume and to their mobility. While in metallic conductors the positive and negative currents, as well as the total current, are the same for every cross section, in gases the positive and negative currents, conveyed by their respective ions, may be very different, even while the total current remains the same. This difference may lead to the formation of strata of positive and negative ions, as in the stratified discharge. There are, in addition to the original electric field, internal charges and stresses which change the relation between E.M.F. and current strength. Originally, the velocity of an ion is proportional to the field. But if the field varies along the path, the proportionality between field and speed is disturbed by what the author terms the "shooting" of the ions, a phenomenon of inertia. The superior velocity of the negative ions gives the kathode a determining influence upon the current strength. In dealing with the electric field within the gas, it is necessary to consider the small fields due to the separate ions, especially in any theory of the luminous phenomena of vacuum tubes. E. E. F.

2203. *Electric Glow in Vacuum Tubes.* **J. Stark.** (Phys. Zeitschr. 1. pp. 396–400, June 16, 1900.)—The regions of luminosity in a vacuum tube are those in which the potential gradient is a relative maximum. In a gas subjected to electric discharge, there are layers in which there is an excess of positive over negative ions and *vice versâ*. In any given region of maximum potential gradient the surface next the anode is positive, and that next the kathode negative. The occurrence of positive and negative layers is caused by the difference in the velocities of the positive and negative ions. In a region of maximum gradient positive ions are driven into a negatively electrified space, and negative ions into a positively electrified space. Since the negative ions travel faster, it is almost as if the positive ions stood still and the negative ions moved towards them. Hence the relative motion of the two classes of ions has a maximum nearer the kathode than the anode in any given region of maximum potential gradient. In a region of minimum gradient, on the other hand, there is very little relative motion of ions, since practically only negative ions traverse it. The regions of maximum potential gradient are also regions of maximum ionisation, since the electric separating force is strongest there.

The author sketches the probable mechanism of the glow produced by electric discharge. When an electron is subject to a sudden impulse whose duration is short in comparison with its own period of vibration, it is put into vibration. Such an impulse results from a sudden disturbance of the electromagnetic field immediately surrounding it, such as might be produced by the passage or impact of an electron of the opposite sign. The author distinguishes between accidental encounters, produced by the original motion of the electrons, and forced encounters, produced by their mutual attraction. The former are directly proportional to the density, and therefore to the pressure of the gas. The latter are nearly proportional to the product of the electrons encountering each other, and therefore increase very rapidly towards regions where there is a maximum relative motion of positive and negative electrons. Des Coudres' experiment, showing an increased luminosity produced by kathode rays impinging upon a positive screen, and a diminished luminosity when they impinge upon a negative screen, is explained by the forced impact in the former case. Since the damping of the vibration is the less the more sudden the impact, it follows that electrons produce the greater luminosity the more rapid their motion, and any increase of speed probably also produces a shifting of the spectrum towards the violet end. E. E. F.

2204. *Helical Vacuum Discharge.* **E. Ruhmer.** (Phys. Zeitschr. 1. pp. 407–409, June 23, 1900.)—The author describes a beautiful new vacuum phenomenon. It is best obtained with a glass tube 1 m. long and 4 cm. wide, provided with projector-shaped aluminium mirrors, 2·8 cm. in diameter, attached to platinum wires at the two ends of the tube. The tube is exhausted to such an extent that the sparks from a 30 cm. coil mounted in parallel just pass the air-gap at 15 cm. distance instead of through the tube. The current used is taken from mains at 110 volts, and is passed through a Wehnelt interrupter. The discharge in the tube has the shape of a red stripe about 1 cm. thick passing straight from one electrode to the other. If then the current is reduced, the stripe breaks up into a succession of glowing patches, and on grasping the tube round the middle, with the positive pole upwards, the discharge falls into the shape of a screw of about six turns, which slowly rotates about its axis. The hand can then be removed, and the phenomenon continues. The screw has sometimes a diameter of 2·5 cm., and is then left-handed. Sometimes its diameter is smaller (0·5 to 1 cm.) and then it is right-handed. But in any case it rotates so as to appear to descend, completing a turn in about seven seconds. The discharge proceeds from fixed points on the electrodes, which do not change during rotation. The pitch depends upon the current strength and the rate of interruption. No explanation is offered as yet. E. E. F.

2205. *High-Frequency Discharges.* **N. Tesla.** (Nature, 62. pp. 116–117, May 31, 1900. Abstract of part of a paper in the Century Magazine, June, 1900.)—A popular description of high-frequency discharges of unusual length, up to 60 or 70 feet. The air is distinctly conducting to such discharges. This conductivity increases very rapidly with rarefaction, so that there is a possibility of utilising the upper strata of the atmosphere at very moderate altitudes for the transmission of electrical energy. W. R. C

2206. *Sparking Distances and Radiation.* **S. Attilio.** (Rivista Sci.-Industriale, 32. pp. 97–100, May 10, 1900.)—The author investigates the influence of the radius of curvature of the terminals of a spark-gap upon the action of ultra-violet light in favouring the discharge. He notes a decided influence of the curvature upon the "neutral distance" between the terminals, at which the light neither impedes nor favours the discharge. With a negative electrode of radius 4 cm. the neutral is about 1 cm. an impeding action setting in above that value. The neutral distance increases as the radius of curvature diminishes, until the impeding action disappears. The latter action is, in general, only obtained with negative electrodes of aluminium or amalgamated zinc. E. E. F.

2207. *Loss of Electric Charge by Evaporation.* **A. Pochettino** and **A. Sella.** (Accad. Lincei, Atti, 9. pp. 8–10, July 1, 1900.)—To decide the question whether the evaporation of a charged liquid produces a dissipation of the charge, the authors examined the dissipation of a charge from a zinc plate, with or without water, when a current of dry or saturated air was passed over it. When the plate was filled with water, and the dry air produced strong evaporation, the rate of dissipation was 20 per cent. greater than when the saturated air passed over the plate and no evaporation took place. But the obvious conclusion that evaporation increases the rate of dissipation is contradicted by the fact that the same difference is found when the zinc plate contains no water at all. In fact, when the air is kept dry, an addition of water to the plate reduces, if anything, the rate of dissipation. The authors conclude, therefore, that the evaporating water does not take any of the charge away with it. This is confirmed by another experiment, in which saturated air was passed over a mixture of ether and water, and no dissipation took place in spite of the evaporation. Moist air acts as a perfect insulator, while dry air is a conductor, probably owing to a state of ionisation. The absence of loss by evaporation confirms the conclusions of Schwalbe, and controverts those of Pellat. E. E. F.

2208. *Kathode Ray Colouration of Fluorspar.* **W. B. v. Czudnochowski.** (Phys. Zeitschr. 1. p. 387, June 9, 1900.)—White fluorspar becomes dark violet and nearly black when exposed to kathode rays for any length of time. By reflected light the surface colour is a kind of bronze. The colouring is confined to the surface, and has no effect upon the colour or intensity of the blue fluorescence of the mineral under the influence of kathode rays. E. E. F.

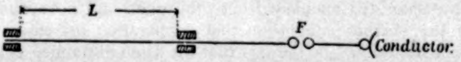
2209. *Theory of Coherer.* **K. E. Guthe** and **A. Trowbridge.** (Phys. Rev. 11. pp. 22–39, July, 1900.)—To investigate the reason of the so-called coherer action a number of experiments were made on ball coherers. The lowering of the resistance of the coherer was produced by the closing of a circuit which consisted of a high E.M.F., which could be varied at will, a variable resistance, and the coherer, all in series. The resistance of the coherer was measured by observing simultaneously the current through, and the potential difference at, the terminals of the coherer. Balls of steel, lead, phosphor bronze, and copper-plated steel were used, and of diameter from 3 to 10 mm. Curves are then plotted with currents as abscissæ, and for the ordinates the corresponding values of potential difference at the coherer terminals. Almost all the resulting curves are expressible by an equation of the form—

$$p = P(1 - e^{-ki}),$$

where p is the potential difference of the coherer when the current through it is i, P and k are constants. It is thus seen that with increasing values of the current i, the potential difference p asymptotes to a limiting value P. The conclusion is drawn that the high original resistance of the coherer may be attributed to a film on the surface of the metallic particles, this film being possibly of condensed water vapour, through which electrolytic action occurs.

E. H. B.

2210. *Mechanical Oscillations of Electrically Luminous Wires.* **O. Viol.** (Phys. Zeitschr. 1. pp. 465–466, July 28, 1900.)—With reference to T. Tommasina's paper on photochemical effects produced by wires carrying electric waves [see Abstract No. 1675 (1900)], the author states that he has observed and recorded by means of a photographic camera luminous waves proceeding from a stretched insulated wire connected to a spark-gap. In the figure, L is the part of the wire which is stretched and insulated. When discharges pass across the gap F, mechanical oscillations are produced along L, which divides itself into bright and dark portions, giving the appearance of a luminous wave. The photographic effect of the luminous portions is weak, but gives satisfactory negatives if the time of exposure is sufficiently prolonged. At first it appears as if the effects were due to electric waves (see W. Coolidge, Wied. Ann. 67, 578, 1899); but the phenomenon is independent of the length of the wire, nor is it noticeably affected by increasing the capacity. The appearance of the waves is determined by the spark-gap. If this is zero, *i.e.*, if the two balls are in contact (the conductor being negatively charged), then the wire is uniformly covered with luminous points. When the balls are moved apart so that sparks pass, luminous waves are seen: the number of these can be varied by varying the length of the spark-gap, and is inversely proportional to it. The pitch of the note heard along the wire is also inversely proportional to the length of the gap.



D. E. J.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2211. *Hall Effect in Gases.* **E. Marx.** (Ann. d. Physik, 2. 4. pp. 798–834, Aug., 1900.)—According to the modern ionic theory, the Hall effect may be calculated from the difference between the positive and negative ionic velocities, and such a calculation, carried out in the case of electrolytes, indicates that no appreciable effect can be expected in them. In gases the electromagnetic transverse and longitudinal effects are very appreciable, but no quantitative results can be as yet obtained owing to the many complications which arise. One case of gaseous conduction, that of flame gases, is, however, sufficiently simple and well known to yield results of theoretical importance. In flame gases the transport of electricity is carried out by electrolytically dissociated ions, whose velocity is about a million times greater than in electrolytes, and shows a considerable difference in the positive and negative ions. The author has, therefore, studied this case experimentally, and has succeeded in finding a Hall effect which is distinctly appreciable, though necessarily small. He used a flat Bunsen flame, into which a fine spray of the solution of some alkaline salt was blown. He found that as the atomic weight of the metallic base of the salt increased, so did the velocity of the ions, and the cæsium ions had therefore the greatest velocity. The Hall effect in electrolytes will probably remain too small for measurement.

E. E. F.

2212. *Measurement of Electric Absorption and Hysteresis.* **L. M. Potts.** (Amer. Journ. Sci. 10. pp. 91–114, Aug., 1900.)—This paper describes experiments made with a view to test the applicability of Rowland's methods of measurement by alternating currents [see Abstracts Nos. 144 (1898) and 1724 (1899)] to the determination of electric absorption in condensers, hysteresis, and other quantities occasioning loss of energy. Rowland's method is to join up a dynamometer with a Wheatstone bridge, the fixed coil in the galvanometer circuit and the moving coil in the arm containing the condenser whose absorption is to be measured. When the resistances of the bridge are adjusted so that the phase difference in the two coils of the dynamometer is 90°, there is no deflection.

A condenser possessing electric absorption is treated as a capacity in series with a resistance, and this apparent resistance is measured on a Wheatstone bridge by Rowland's method. Full details of the experiments are given. The apparent resistance is independent of the current, but increases rapidly with the temperature. The capacity of a condenser may be compared with a self-induction standard to 1 part in 1,000, after applying a correction for the absorption measured as indicated.

If a coil be substituted for the condenser, the hysteresis loss in its iron core may be measured by the same method; only a very small quantity of iron is necessary.

A short circuit may be detected in one of two similar coils by approaching them successively to a coil in the bridge-arm, and comparing the apparent increase of resistance occasioned by their presence. G. H. B.

2213. *Dielectric Hysteresis.* **F. Beaulard.** (Journ. de Physique, 9. pp. 422–437, Aug., 1900.)—To decide between the rival hypotheses of viscosity and dielectric hysteresis, framed to account for the dissipation of energy observed in dielectrics subjected to changing fields, the author employs the method of Porter and Morris (see Electrician, April 12, 1895) and exposes various dielectrics to cyclic variations of different frequencies. Paraffin condensers show little or no loss of energy, and mica condensers very little. Condensers of "dielectrine" show hysteresis areas bordered by straight lines when subjected to four different potentials in rotation. It is found that the energy dissipated varies with the rate of variation of the cycle, and tends to disappear when the rate decreases indefinitely. The apparent hysteresis is, therefore, a phenomenon of viscosity, best explained on Pellat's assumption of a progressive polarisation having a lag with respect to the polarising force [see also Abstract No. 1678 (1900)]. E. E. F.

2214. *Resistance of Thin Metallic Films.* **A. C. Longden.** (Amer. Journ. Sci. 9. pp. 407–409, June, 1900. See also Phys. Rev. 11. pp. 40–55, July, and 84–94, Aug., 1900.)—A study of the electrical resistance of thin films of metals deposited upon glass by kathode discharge in exhausted tubes, as described by A. W. Wright (Amer. Journ. Sci. 13. pp. 49–55, and 14. pp. 169–178). The films have enormously high electrical resistance—very much higher, as compared with thicker films of the same kind, than their thickness would seem to indicate. All very thin films have negative temperature-coefficients, and films within a certain range of thickness have zero or negligible temperature-coefficients. After suitable artificial ageing and subsequent protection from the atmosphere, thin films may be regarded as perfectly trustworthy standards of resistance ; the artificial ageing process must, however, be thorough. Contact with the terminal wires is made by depositing very thick films of negligible resistance on the ends of the thin films. The joints between the wires and the thick films are then secured by electro-deposition of copper and silver upon them. The resistances may be anything from a few ohms to several megohms. They can be made of pure metals and are thus free from the danger of disintegration common to alloys : they have the advantages of high resistance and low temperature coefficients which alloys possess. D. E. J.

2215. *Thermo-electric Currents.* **H. Egg-Sieberg.** (Elektrotechn. Zeitschr. 21. pp. 619–621, July 26, 1900.)—The author describes his repetitions of the early experiments of Le Roux, Ritter, and others on the phenomena of thermo-electricity, which lead him to suggest a slight modification in the statement of the hypothesis of F. Kohlrausch as to the origin of thermo-electric currents. This hypothesis he would express thus : In an unequally heated conductor electromotive forces prevail whose direction and magnitude depend on the nature of the conductor and on the existing temperature gradients. It is suggested that the earth's magnetism may be due to earth currents which have a thermo-electric origin. J. J. S.

2216. *Effects of Twist on the Thermo-electric Qualities of Iron.* **K. Tsuruta.** (Phil. Mag. 50. pp. 223–231, Aug., 1900.)—A description is given of some incomplete experiments carried out by the author in 1895 which indicate : (1) That in soft iron of certain kinds there exists the phenomenon of thermo-electric hysteresis with respect to twist ; (2) that, other things being equal, the hysteresis is reversed at a certain twist ; (3) that mechanical agitation has its own effects, which are reversed as the hysteresis is reversed. J. J. S.

2217. *Thermo-electric Power of Steels.* **G. Belloc.** (Comptes Rendus, 131. pp. 336–337, July 30, 1900.)—Curves of thermo-electric power between the temperatures 15° and 1,200° for three specimens, A, B, and C, are found to be similar in shape.

		Per cent. Carbon.
A	Soft iron	traces
B	Soft steel	0·30
C	Hard steel	1·25

The couples were formed between platinum and the respective specimens and tested in vacuo in an electric furnace, a third, a platinum rhodium wire, being present to give the temperature.

Temperature.		100°	470°	650°	770°	800°	860°	900°	940°	1,100°
dE/dt in microvolts.	A	20	9·9	13·6	18	18·8	19·2	15	11·2	15
	B	18	9·8	14	18·4	17·6	11	9·6	10·6	15·8
	C	16·5	10	14·4	7·6	7	9	11	12·4	17

The E.M.F. is smaller during cooling than during heating, especially between the maximum operating temperature and the temperature giving the maximum of the curve. Certain experiments show that viscosity and hysteresis play a *rôle* at high temperatures. G. E. A.

2218. *Electrolytic Interrupters.* **B. F. Bailey.** (Elect. World and Engineer, 36. pp. 207–210, Aug. 11, 1900.)—In the Caldwell interrupter the action is symmetrical on both sides of the hole in the glass partition, and therefore the action on each half of the alternate-current wave is the same, both being interrupted. The time of complete interruption seldom lasts longer than $\frac{1}{5000}$ of a second. It is quite possible to obtain two breaks in a single wave by means of the Caldwell interrupter. In the accompanying diagram (Fig. 1) curve A represents the double interruption in a circuit in which the current was about 2 amperes at 150 volts and 40 cycles per second. The inductance of the circuit was 0·062 henrys. Curve B was taken under the same conditions, except that the inductance was reduced to $\frac{1}{38}$ of its former

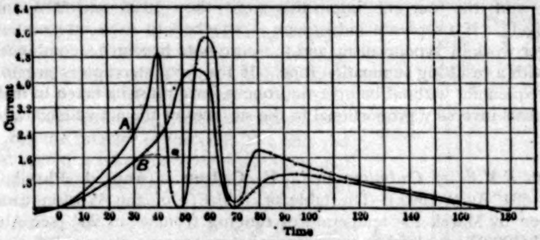


FIG. I.

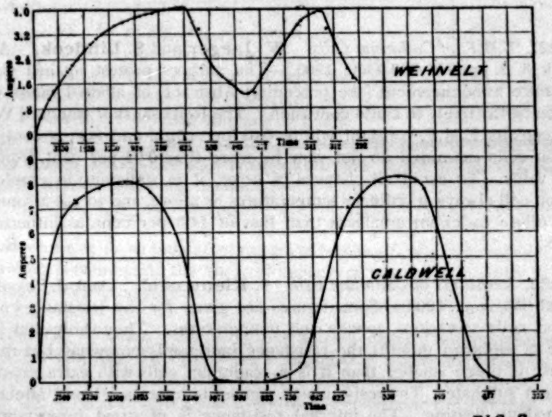


FIG. 2.

value. The author has also devised a contact-maker for direct-current work, which enables him to explain the apparently large consumption of power by the electrolytic interrupter as due to the fact that the E.M.F. and the current do not coincide in phase. Fig. 2 gives the first two waves of a Wehnelt and a Caldwell interrupter respectively. In the former, the interruption is not complete. In the latter, the first wave rises more steeply than the second, owing to the fact that the hole is full of liquid and the first part of the curve is that of the rise of the current in an inductive circuit. E. E. F.

2219. *Wehnelt Interrupters in Parallel.* **E. Ruhmer.** (Elektrotechn. Zeitschr. 21. pp. 699–700, Aug. 16, 1900.)—When two Wehnelt interrupters are connected in parallel their interruptions are synchronous, though they may have naturally very different frequencies. Two or more Wehnelt or Caldwell-Simon interrupters mounted in parallel are equivalent to a single interrupter having a platinum surface or perforation area equal to the sum of the surfaces or areas taken singly. Out of two interrupters studied, one had an effective anode surface of 9·18 sq. mm., and the other 18·35 sq. mm. The natural frequencies were 1,460 and 1,170 interruptions per second, with 12 and 22·5 amperes respectively. The combined interrupter had a frequency of 790 per second, and the current intensities were then 10·25 and 20·5 amperes respectively. If a separate inductance is attached to each interrupter, they no longer work in synchronism, and the pure note becomes a combination of notes, with a resulting summation tone. If the two interrupters are to have equal frequencies without being synchronous, care must be taken to make the inductances inversely proportional to the surfaces of the active electrodes.
E. E. F.

2220. *E.M.F. of Cadmium Cell.* **E. Cohen.** (Ann. d. Physik, 2. 4. pp. 863–864, Aug., 1900.)—The table of E.M.F.'s of the Weston cadmium cell given by Marek for temperatures ranging from 5° to 26° [see Abstract No. 1091 (1900)] may lead to grave errors below a temperature of 23°, since the cell is completely metastable below that point. The table of E.M.F.'s therefore only retains its value between the temperatures of 23° and 26° C.
E. E. F.

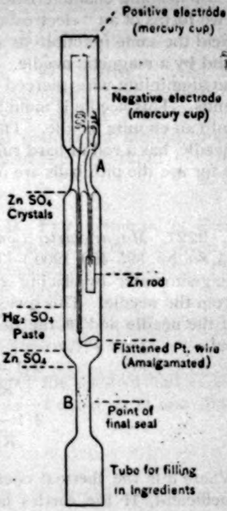
2221. *E.M.F. of Cadmium Cells.* **W. Jaeger** and **S. Lindeck.** (Ann. d. Physik, 3. 2. pp. 366–368, Oct., 1900.)—The authors protest against Cohen's premature announcement [see preceding Abstract] of alleged faults in the Weston cell as likely to cause confusion. The Reichsanstalt standard Weston cell keeps its E.M.F. constant within 0·01 per cent., and 80 per cent. of all Weston cells examined do not vary by more than 0·02 per cent. from their mean value. To avoid all chances of error, it is sufficient to employ the Weston cell always at ordinary temperatures or above, and to use a somewhat more dilute cadmium amalgam than that of 14·3 per cent. as hitherto prescribed.
E. E. F.

2222. *Resistance of Cadmium Cell.* **I. Klemenčič.** (Ann. d. Physik, 2. 4. pp. 848–853, Aug., 1900.)—Some figures are given for the resistances of two Weston cells at various epochs and temperatures. They show that in the course of eighteen months the resistance increased somewhat, but that the increase is much smaller than it is in cadmium cells with extra crystals of cadmium sulphate. The resistance at a given temperature is not affected by intermediate heating. The internal resistance is of great importance for practical use. Its constancy in the Weston cell is largely due to the efficient sealing of the cell.
E. E. F.

2223. *An Adjustable Condenser.* **L. J. Briggs.** (Phys. Rev. 11. pp. 14–21, July, 1900.)—This paper describes a condenser whose capacity is capable of continuous adjustment within limits. It consists of a stack of conducting and insulating plates placed alternately. The conducting plates are formed of thin spring brass sheets slightly curved; the insulating plates each consist of two sheets of mica. These plates are arranged in an insulated frame with a compression screw at the top. As this is screwed up the brass plates are flattened and the dielectric space diminishes, thus increasing the capacity. On releasing the screw the brass plates recover their original curvature.

E. C. R.

2224. *Hermetically Sealed Clark Cell.* **H. T. Barnes.** (Phys. Rev. 10. pp. 268–276, May–June, 1900.)—This cell is a "crystal" cell, so constructed that the glass containing-tube may be sealed off in the blowpipe. The arrangement will be readily understood by referring to the figure. A platinum wire, which is flattened and amalgamated at one end, is used instead of mercury. It is sealed into a glass tube which is large enough to form a mercury cup at one end, but is a capillary along that part which projects into the interior of the cell. The zinc rod is cast round a platinum wire, and also round the end of the capillary glass tube through which this wire passes. These two capillary tubes are fused into the neck A of the main tube, connection being made with the platinum terminals when required by means of mercury. The zinc is amalgamated by dipping into mercury, on the top of which is a layer of dilute sulphuric acid. In filling the cell, moist zinc sulphate crystals are pushed through the neck B until the zinc rod is covered. A layer of mercurous sulphate paste is then inserted, and finally a thin layer of zinc sulphate crystals in order to protect the paste from the heat when the neck B is sealed off.


Positive electrode (mercury cup)
Negative electrode (mercury cup)
A
Zn SO₄ Crystals
Zn rod
Hg₂ SO₄ Paste
Flattened Pt. wire (Amalgamated)
Zn SO₄
B
Point of final seal
Tube for filling in ingredients

The change of E.M.F. with temperature was found to be expressed in millivolts by the following equation:—

$$E_t = E_{15} - 1{\cdot}200\,(t - 15) - 0{\cdot}0062\,(t - 15)^2.$$

The cells appear to be satisfactory as regards permanence and reproducibility. The author recommends the short circuiting of new cells in order to bring them into a steady condition.

W. R. C.

2225. *The "Column" Measuring Instruments.* (Elect. World and Engineer, 36. pp. 222–225, Aug. 11, 1900.)—Air is supplied at a pressure of about 1¾ lbs. per square inch to a chamber partially filled with a non-volatile oil, into which dips a vertical tube graduated with the scale of the instrument. Before reaching the chamber the air passes through a series of filter-paper diaphragms and a passage from which a valve opens to the atmosphere. The pressure on this valve, and consequently the height to which the oil rises in the tube, is regulated by a coil carrying the current to be measured and capable of motion along one leg of a horseshoe permanent magnet. As the motion of this coil is very small (less than $\frac{1}{100}$ inch) the pressure it exerts on the valve is exactly proportional to the current through it.

Several indicating tubes can be attached by tubes to the chamber of one instrument. The air is supplied either by a small pump run by a motor or by a water injector.

The instrument can be made to record, by attaching a pen to a float on the surface of the oil column. The makers are The Whitney Electrical Instrument Co. G. H. B.

2226. *Needle for Exploring Electrostatic Fields.* **F. J. Rogers.** (Phys. Rev. 11. pp. 56–58, July, 1900.)—In order to render evident to a class the existence and characteristics of an electrostatic field the author has devised two forms of an "electrostatic needle." These perform for the electrostatic field the same functions as are performed for the magnetic field by iron filings and by a magnetic needle. The form analogous to an iron filing consists of an aluminium wire pierced at the centre, and provided with pith balls at its ends. This needle is mounted on a horizontal axis consisting of a pin stuck into an ebonite handle. The second form of needle, analogous to a magnetic needle, has a rod of hard rubber in place of the aluminium wire. To prepare it for use the pith balls are oppositely charged from an electrical machine. E. H. B.

2227. *Magnetometer Constant.* **C. Chistoni.** (Acad. Sci. Torino, Atti, 35. 8*a*. pp. 395–409, 1900.)—The author determines the constant of a unifilar magnetometer by placing a deflecting magnet at two distances, R_1 and R_2, from the needle. This gives the deviations ϕ_1 and ϕ_2, while the temperatures of the needle and of the deflecting magnet are τ_1 and τ_2 respectively. Then put—

$$\frac{2(1-a\tau_1)(1-h\,H\sin\phi_1)}{R_1^3(1+3\beta\tau_1)\sin\phi_1}=A_1$$

$$\frac{2(1-a\tau_2)(1-h\,H\sin\phi_2)}{R_2^3(1+3\beta\tau_2)\sin\phi_2}=A_2$$

Where a is the thermal coefficient of the deflecting magnet, h its induction coefficient, H the earth's horizontal force, and β the coefficient of linear expansion of the scale. Then the magnetometer constant p is given by—

$$p=\frac{(A_1/A_2-1)R_1^2(1+2\beta\tau_1)}{\dfrac{R_1^2(1+\beta\tau_1)}{R_2^2(1+\beta\tau_2)}-\dfrac{A_1}{A_2}} \qquad (1)$$

From this exact formula the following approximate formula may be deduced—

$$\log p=\log C+\log[(\log\sin\phi_1-\log\sin\phi_2)+\log C] \qquad (2)$$

where—

$$C=-\frac{R_1^2}{(R_1^2/R_2^2-1)\log e}$$

and—

$$\log C=[\log 1+a(\tau_1-\tau_2)]+\log[1+hH(\sin\phi_1-\sin\phi_2)]+\log\frac{R_1^3}{R_2^3}$$

The author shows, in reply to Palazzo's criticism, that formula (1) is rigorously correct, and that formula (2) can be used in most cases, though care must be taken against neglecting the term involving h. E. E. F.

2228. *Electrical Measuring-Instruments.* **J. F. Stevens.** (Frank. Inst., Journ. 150. pp. 44–62, July, 1900.)—In this paper the author discusses the advantages and disadvantages of the various forms of measuring instruments used on electric lighting circuits. Some figures are given showing that hot wire shunt ammeters are not satisfactory, one for 1,000 amperes requiring 8 H.P. to operate it, when tested. A novel form of hot-wire instrument is also described, consisting of an aneroid barometer with a resistance wire in the expanding chamber. These instruments can be made to be accurate, but they necessarily act slowly. C. K. F.

ALTERNATING CURRENTS AND MAGNETISM.

2229. *Current Curves by Lichtenberg Figures.* **W. König.** (Ann. d. Physik, 2. 4. pp. 860–862, Aug., 1900.)—In comparing his own method of recording potentials with Grützner's electrolytic current records [see Abstract No. 1478 (1900)], the author admits that both are of limited range of application. The electrolytic method is unsuitable for rapid electric oscillations. E. E. F.

2230. *Resonance in Transmission Work.* **D. H. Fry.** (Journal of Electricity, S.F. 9. pp. 61–62, April, 1900.)—A simple, practical method is given of analysing alternating E.M.F. waves into their constituent harmonics. The special form of Fourier's theorem for an E.M.F. wave is—

$$\begin{aligned} e = {} & a_1 \sin \phi + a_3 \sin 3\,\phi + \ldots + a_{2n-1} \sin (2n-1)\,\phi + \ldots \\ & + b_1 \cos \phi + b_3 \cos 3\,\phi + \ldots + b_{2n-1} \cos (2n-1)\,\phi + \ldots \end{aligned}$$

To determine a_{2n-1} and b_{2n-1} from a drawing of the positive half of the E.M.F. wave, divide the base of the curve into $4n-2$ equal parts and draw the $4n-3$ ordinates, $e_1, e_2, \ldots e_{4n-3}$.

Then approximately—

$$a_{2n-1} = \frac{1}{2n-1}\,(e_1 - e_3 + e_5 - \ldots + e_{4n-3}),$$

and—

$$b_{2n-1} = \frac{1}{2n-1}\,(-e_2 + e_4 - \ldots + e_{4n-4}).$$

Hence the $(2n-1)$th harmonic is $A_{2n-1} \sin [(2n-1)\,\phi + \alpha_{2n-1}]$, where—

$$A_{2n-1} = \sqrt{a_{2n-1}^2 + b_{2n-1}^2},$$

and—

$$\tan \alpha_{2n-1} = \frac{b_{2n-1}}{a_{2n-1}}.$$

An example is worked out showing that the method is a simple one and that it gives accurate results. Some remarks are made as to the effects of harmonics in the polyphase working of transmission lines. A. R.

2231. *Permeability of Iron under the Influence of the Oscillating Discharge from a Condenser.* **E. W. Marchant.** (Nature, 62. p. 413, Aug. 30, 1900.)—Photographs are given of sparks taken with the aid of a revolving mirror from a coil of five millihenrys self-induction and a Leyden jar of 0·06 microfarads, the difference of potential before discharge being 13·5 volts. The effect of the soft iron core upon the nature of the spark is well shown. The first half oscillation with the core in is seen to be nearly twice as long as without it, and a series of oscillations follow it gradually increasing in length.

The increased length of the first spark is due of course to the increase in the self-induction of the coil by the introduction of the core, and the gradually increasing length of the sparks that follow is due to the increased permeability of the core as the intensity dies away. Over three hundred spark-photographs have been taken, and iron has been found to act in the same way under these oscillatory discharges as it does where steady currents are used to produce magnetising forces of the same intensity. In some experiments the magnetising current was 1,000 amperes, and this was obtained by using a large glass condenser, capacity 1·5 microfarads, formed of plates of glass 1·6 mms. thick, coated with shellac, the conducting surfaces being of tin-foil. The condenser was charged by a large Wimshurst machine of 160 plates and a full difference of potential of 20,000 volts. W. C. O.

2232. *Electromagnetic Rotations.* **W. König.** (Ann. d. Physik, 2. 4. pp. 854–860, Aug., 1900.)—The author replies to Lecher's criticism [see Abstract No. 94 (1900)], and maintains that the current explanation of Pohl's experiment is correct, unless it is assumed that the lines of force are rigidly attached to the magnet. E. E. F.

2233. *Magnetic Observations near Electric Tramways.* **T. Moureaux.** (Comptes Rendus, 131. pp. 337–340, July 30, 1900.)—In order to accommodate the instruments which record curves of magnetic variation in the Parc St. Maur Observatory, Paris, so that the disturbances proceeding from the electric tram service 3,200 metres distant may be rendered negligible, three modifications have been made on a declinometer and a bifilar. These are the use of square-ended, strongly magnetised bars, 5 cm. long, the addition of a special stirrup which increases the moment of inertia of the oscillating system by one-third, and the disposition of the magnet so that it oscillates just above a copper plate. The indications of a normal bifilar show that the changes made reduce the perturbations to one-tenth of their value. G. E. A.

2234. *Behaviour of Fluids in the Magnetic Field.* **G. Jäger.** (Akad. Wiss. Wien, Sitzb. 108. pp. 1499–1509, 1899.)—Duhem's formula is only applicable to dilute solutions which cannot be investigated experimentally, and an investigation is now given of the behaviour of a liquid in a ring-shaped vessel in one side of which the meniscus is in a magnetic field. No change in the capillarity-constant of a liquid could be observed in a powerful magnetic field; but when the liquid is a solution in a non-magnetic solvent it is shown that a change in the vapour-tension must occur, and that this can only be caused by a change in the concentration of the solution, and that a slight potential difference must occur, the value of which can be calculated. An experiment gave only indecisive results. T. M. L.

2235. *Magnetic Deposits formed in a Magnetic Field.* **C. Maurain.** (Comptes Rendus, 131. pp. 410–413, Aug. 13, 1900.)—On electrolysing a solution of ferrous sulphate in sodium pyrophosphate arranged inside a magnetising spiral, adherent brilliant deposits of iron are obtained, the magnetisation of which may be measured by means of a magnetometer. During the formation of a deposit in a field of constant strength by a constant electrolysing current, for the first few minutes there is no action on the magnetometer; but after this period the action increases very nearly proportionally with the time, so that the intensity of magnetisation is constant for the different layers of the deposit. Also by using fields of different strengths it is found that the intensity of magnetisation acquired by a deposit increases with the strength of field in which it is obtained. If, after a deposit has been formed in a constant field, the latter be gradually decreased to zero, the action on the magnetometer shows only a very slight variation. When the strength of field is increased from the initial value H_0 the magnetisation of the deposit increases slowly if H_0 is large, but quickly if H_0 is small; if H_m is the maximum value reached by the strength of field, and the latter be then continuously decreased, the magnetisation decreases very slowly, even when the field becomes of negative sign. On reaching a value $-H_1$, arithmetically much greater than H_m, the magnetisation diminishes very rapidly to a value much greater than that obtained for the strength of field H_m unless the latter brought the iron near to saturation. These variations are shown by the following table, in which the values of H represent the successive values given to the strength of field, and I the corresponding deflections of the magnetometer.

H	+ 2·65	+ 14·8	− 18·5	− 23·3	+ 18	+ 23·2	− 19	− 23·1	0
I	+ 98·7	+ 129·4	+ 104·1	− 180·2	− 160	+ 174	+ 162·6	− 183·6	− 178·1

The coercive force is therefore enormous, and the reversal of the magnetisation is effected suddenly for a very small variation in the field. T. H. P.

2236. *Effects of Temperature on the Magnetic Properties of Iron and Alloys of Iron.* **R. L. Wills.** (Phil. Mag. 50. pp. 1–37, July, 1900.)—Ewing divides the magnetising process of magnetic metals into three stages. During the first stage the permeability is small and there is practically no retentiveness. In the second stage the curve of magnetisation rises rapidly and the permeability is high. In the third stage the permeability decreases and the specimen approaches saturation. The effect of heat is to make the transition from one stage to another occur at lower values of the magnetising force, but the temperature effect has previously only been studied for magnetising forces so large that the heat applied has brought on the second stage of the magnetising process. In the present investigation the author has studied the influence of temperature on the permeability for small values of the magnetising force. The metals used were iron and alloys of iron with tungsten, aluminium, and nickel, and a steel containing chromium and manganese which was non-magnetic in the unannealed state, but became magnetic on being annealed.

The metals were obtained in the form of rings which were wound with the magnetising coils, the induction being measured ballistically on reversing the magnetising current. The magnetising force was kept constant and the temperature gradually raised, the induction being measured at certain temperature intervals until the non-magnetic state was reached. The permeability-temperature curves thus obtained for different values of the magnetising force are plotted in the paper, as are also μ-H curves for constant temperatures, up to about 800° C., obtained directly by experiment, the temperature being kept constant while H was varied.

The results for the different metals are best studied from the curves.

J. B. H.

2237. *Magnetic Declination at Greenwich.* **A. Schuster.** (Cambridge Phil. Soc., Trans. 18. pp. 108–135, April, 1900.)—The author gives a method of analysing complex variation curves, by means of Fourier's series, which is capable of discriminating between accidental and truly periodic variations, If $f(t)$ is any function of t, and the quantity R is determined by the equations—

$$\tfrac{1}{2}n\mathrm{TA} = \int_{\tau}^{\tau + n\tau} f(t) \cos \kappa t \, dt$$

$$\tfrac{1}{2}n\,\mathrm{TB} = \int_{\tau}^{\tau + n\tau} f(t) \sin \kappa t \, dt$$

$$\mathrm{R}^2 = \mathrm{A}^2 + \mathrm{B}^2$$

where $\kappa = 2\pi/\mathrm{T}$, n is an integer, T represents a certain interval, and τ a time which can be varied, then a change in τ with constant n and T will cause R to fluctuate round some mean value. Let S^2 be the mean value of R^2 which will in general depend upon T, with T as abscissa and S^2 as ordinate, draw a curve, which may be called the *periodograph*. Then the author defines the *periodogram* as the surface included between this curve and the axis of T. The periodograph corresponds exactly with the curve which represents the distribution of energy in the spectrum. The author discusses several special cases, in one of which the function $f(t)$ is formed by the superposition of one or more simple periodicities on an irregular curve varying within certain limits. This is the case of barometric, thermometric, and magnetic changes. When the periodicities are real, the value of the ordinates of the periodogram is independent of the range of time over which the integration is performed, whereas it varies inversely with the time when they are accidental.

This method was applied to the Greenwich declination records of the twenty-five years (1870–1895). It was found that the causes which produce the variations of declination are, on the whole, persistent in character, so that the variations of short periods have on the average a much smaller amplitude than those of longer periods. When the square of the amplitude (the "intensity") of a disturbance becomes seven times its expectancy or probable value, the probability of a real effect is 1,000 to 1. Applying this to the alleged 27-day period, it appears that there is no period between 25·5 and 27·5 days whose amplitude exceeds 0·077 minute of arc. But within that limit, the probability of a synodic lunar period of amplitude 0·054 minute is established with a probability amounting to 2,000 to 1. E. E. F.

2238. *Magnetic Disturbances in the Island of Skye.* **A. Harker.** (Cambridge Phil. Soc., Proc. 10. pp. 268–278, May 7, 1900.)—The disturbances described by the author are found in the Cuillin Hills, composed mainly of gabbro, which occupy the central part of the island, and on the moorland plateaux, consisting of basalt, which extend thence northward and westward, covering about half the area of Skye. On any salient point, either of the gabbro mountains or the basalt plateaux, the rocks are permanently magnetised, and very often to such an extent that, by moving the compass about, the needle may be made to point in any direction. The disturbance affects dip as well as declination, so that, with the dial held horizontally, the needle will often jam against the card. When a rock-face forming part of such an eminence is tested more closely with the compass, it is found that certain points of the rock behave as north poles and others as south poles, such poles being irregularly distributed at intervals varying from a few inches to a few feet.

These phenomena are not confined to high mountain-summits, but are exhibited equally by insignificant knolls on the moorland plateaux, provided they form the highest ground in their immediate neighbourhood. The localisation of these intense magnetic disturbances in such situations seems to point very decidedly to atmospheric electricity as the cause of the magnetisation of these salient points of rock. It is not necessary to suppose that the exposed points have been struck by lightning. Indeed, the remarkable rarity of thunderstorms in Skye rather suggests that the summits act to some extent as lightning-conductors. It is easy to show too that no great lapse of time is required for rocks so exposed to become magnetised. The stones composing the cairns erected by the Triangulation Survey are invariably highly magnetic, while the loose stones lying about the base of the cairn are much less so. This is true even of small cairns erected by climbers within a few years past. E. E. F.

MEDICAL ELECTRICITY.

2239. *Oscillating Rheostat for Producing Current Waves.* **S. Leduc.** (Archives d'Él. Médicale, 8. pp. 300–306, July, 1900.)—A brass wire in the form of a horseshoe is varnished with collodion on one side, and the extremity of the varnished end cut to give a conducting surface. The end of the unvarnished side is attached to the pendulum of a metronome interrupter, the other end being balanced with a lead wire. The varnished end is plunged into a glass, at the bottom of which is placed some mercury. The pendulum of the metronome is connected with one of the poles of a generator, the other pole being connected with the mercury in the glass. In the circuit thus formed is placed a physiological subject. On the mercury a badly conducting liquid is placed, such as filtered water, which closes the circuit. The metronome being started, the brass wire is successively raised and lowered so that the unvarnished end approaches the mercury without touching it and recedes without leaving the water. The intensity of the current is thus periodically varied, and the variation is measured by the variation of muscular contractions. W. G. R.

2240. *Influence of Static Electricity on the Healthy Organism.* **P. Yvon.** (Archives d'Él. Médicale, 8. pp. 256–276, June, 1900.)—The object of the investigation was to determine the action of the "static bath" on the elimination of urea and of phosphoric acid, as well as its action upon respiration, circulation, and the temperature of the body. The writer experimented upon himself, one pole of the machine being to earth the other attached to the insulating stool upon which he sat. The duration of each bath was two hours. Neither the "souffle," "friction," nor "sparks" were used. A Wimshurst machine without sectors was employed, giving, between the knobs, sparks of about 9 centimetres in length, that is to say, with a potential of about 115,800 volts, according to Mascart's table. The conclusion from the first series of experiments was that the action of the static bath (and of the ozone produced) upon temperature, pulse, and respiration was practically nil. The effect upon the output of urea and phosphoric acid was not sufficiently marked to draw any conclusion whatever. A second series of experiments, undertaken with more elaborate precautions against possible errors, fully confirmed the above results; the writer concludes that the physiological action of static electricity upon the healthy organism is very slight, if, indeed, such an influence exists at all under the conditions in which the above experiments were carried out.

The opinion of Duchenne (of Boulogne), who wrote in 1855 that static electricity produced no physiological effect, is fully confirmed by the above experiments. (Elaborate tables accompany the paper.) W. S. H.

2241. *Action of High-Frequency Currents upon the Activity of the Exchanges between the Blood and the Tissues.* **Tripet.** (Comptes Rendus, 130. pp. 1785–1787, June 25, 1900.)—D'Arsonval having shown the powerful influence of high-frequency currents in modifying nutrition, and Apostoli and Berlioz having proved their effect in increasing the output of urea, the present writer undertook a series of experiments to show the effect of such currents upon the activity of the reduction of oxyhæmoglobine, *i.e.*, upon the activity of the exchanges between the blood and the tissues. For two years he followed a series of cases in Apostoli's clinic before, during, and after their treatment by currents of high frequency, and fifty-three observations are tabulated for presentation to the Academy. The results of this treatment may be summed up as follows: (1) In thirty-seven cases the activity of the reduction of oxyhæmoglobine was increased—a fact which especially appeared in cases of perverted nutrition (rheumatism, uterine fibroids, &c.). (2) In ten cases where, before the treatment, the reduction was excessive it afterwards became normal. (3) In only six cases in which the disease did not prove amenable to treatment the activity of the reduction of oxyhæmoglobine continued to decrease.

We may conclude, therefore, that (*a*) In diseases of nutrition treatment by high-frequency currents has a regulating effect on the activity of the reduction of oxyhæmoglobine. (*b*) In cases where this activity is below the normal it becomes increased. (*c*) In cases where this activity is exaggerated—for example, in diabetes—the treatment diminishes it. (*d*) It is to be remarked that there is almost always a simultaneous increase in the percentage of oxyhæmoglobine and its activity of reduction. W. S. H.

2242. *Hertzian Franklinisation.* **H. Bordier.** (Archives d'Él. Médicale, 8. pp. 241–255, June, 1900.)—The writer considers that the appellation "Static Induced," hitherto given to the currents of Morton, is an unsatisfactory term, and proposes instead the term *Hertzian Franklinisation.* In electrotherapeutics Franklinisation is the name usually given abroad to treatment by the static machine. It embodies three chief applications: the static bath, sparks, and the electric breeze. To justify the qualifying term, *Hertzian*, the author enters into a lengthy explanation of Hertzian phenomena. He then considers the conditions of the Morton method (Static Induced). In this arrangement two Leyden jars are attached to the collectors of the static machine by their internal armatures; of the external armatures one is put to earth, the other is attached to the exciter for application to the body. The terminals of the machine are then approximated, so that sparks of the desired length pass between the knobs when the machine is in action.

To examine the electrical phenomena which occur under such conditions, he deals in detail with various modifications of Morton's arrangement, and considers that, the production of Hertzian vibrations and a Hertzian field being duly proved, the new name which he suggests, viz., Hertzian Franklinisation, is fully justified. W. S. H.

2243. *Alternating Current Transformer for Medical and Industrial Use.* **P. Renaud.** (Électricien, 19. pp. 353–354, June 9, 1900.)—This apparatus, designed by Gaiffe, of Paris, is intended chiefly for the use of medical men who have an alternate current lighting-circuit. It is composed of a primary and two secondary circuits, the latter being so arranged that any number of turns can be used according to the purpose in hand. The originality in the apparatus consists in the fact that the two secondaries can be used at the same time and for different purposes. It can either be used for cautery, light, or direct application to the patient. The different values of the current rendered are as follows :—

Circuit 1·0 to 8 volts, 0 to 30 amperes.
„ 2·0 to 16 „ 0 to 2 „
„ 12·0 to 24 „ 0 to 2 „

For medical use the first circuit is employed for cauteries which take 2 to 8 volts and 10 to 30 amperes. The second circuit would supply exploring lamps which take 2 to 10 volts and 0·5 to 1·5 amperes.

For alternating currents to be applied directly to the body the maximum required would be for the electric bath. For this 20 volts are sufficient to obtain the 100 or 125 milliamperes, which is the strongest current that can be borne. W. S. H.

REFERENCES.

2244. *A Percentage Bridge.* **H. C. Parker.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 229–232, April, 1900.)—A method is described of using an ordinary wire bridge to compare two resistances which are nearly equal to one another. Two "percentage" coils (methods of calculating which are given) are placed at the ends of the wire and the readings on the wire are then in percentages which greatly simplifies the calculation. A. R.

2245. *De-cohering Action of Current.* **S. Marcucci.** (N. Cimento, 11. pp. 173–177, March, 1900.)—The author describes in detail several cases in which the conductivity of a coherer is annulled by sending a feeble current through it. E. E. F.

2246. *Electric Distribution along a Hertz Resonator.* **A. Turpain.** (Comptes Rendus, 130. pp. 1609–1611, June 11, 1900.)—A study of the oscillatory current in a circular Hertz resonator by a method which consists in enclosing the resonator in a glass tube, inside which the air is suitably rarefied. D. E. J.

2247. *Kathode Rays.* **E. Merritt.** (Science, 12. pp. 41–48, July 13 ; and pp. 98–104, July 20, 1900. Address of the Chairman of Section B of the American Association.)—Historical.

2248. *Theory of Unipolar Gas-Discharges.* **E. v. Schweidler.** (Akad. Wiss. Wien, Sitzb. 108. pp. 899–904, 1899.)—In connection with his investigations on photo-electric phenomena [see Abstract No. 141 (1900)] the author has endeavoured to deduce theoretically relations between the current, electromotive force, distance between electrodes, &c. The results of his calculations do not entirely agree with the experimental observations. D. E. J.

2249. *Distribution of Currents and E.M.F.'s in a Network of Conductors.* **L. Donati.** (Elettricità, Milan, 19. pp. 356–358, June 9, 1900. Read before the R. Accademia delle Scienze dell' Istituto di Bologna, Nov. 26, 1899, and Feb. 11, 1900.) —The author deduces formulæ connecting the values of the E.M.F.'s and currents in a network of wires and discusses some applications. G. H. B.

2250. *Dynamics of a System of Electrons.* **J. Larmor.** (Cambridge Phil. Soc., Trans. 18. pp. 380–407, April, 1900.)—A mathematical paper on the dynamics of a system of interacting electrons or ions, and on the influence of a magnetic field on optical phenomena. J. J. S.

2251. *Use of Chronograph in Electrical Measurements.* **W. Marek.** (Elektrotechn. Zeitschr. 21. pp. 641–643, Aug. 2, 1900.)—After a brief description of the chronograph, the author considers its use in the determination of the constants of supply meters, the frequency of alternate currents, and the period of oscillation of a galvanometer. A. H.

2252. *Residual Magnetism and Coercive Force.* **Colard.** (Soc. Belge Élect., Bull. 17. pp. 178–201, May, 1900.)—The author discusses the subject of magnetic circuits having a gap, and emphasises the demagnetising effect of the gap. W. H. E.

2253. *Mechanical Model Illustrating the Behaviour of Geissler Tubes.* **W. Kaufmann.** (Phys. Zeitschr. 1. pp. 59–60, 1899.)

2254. *Electric Discharge in Helium.* **W. Heuse.** (Deutsch. Phys. Gesell., Verh. 2. 2. pp. 16–18, 1900.)

2255. *Molecular Susceptibilities.* **H. du Bois** and **O. Liebknecht.** (Deutsch. Phys. Gesell., Verh. 2. 2. pp 19–21, 1900.)—A paper similar to that referred to in Abstract No. 1096 (1900). E. E. F

2256. *Measurements of Polarisation.* **F. Haber.** (Zeitschr. Elektrochem. 7. pp. 13–15, July 5, 1900.)—A description is given of a bridge consisting of a stretched platinum-iridium wire, about one metre long, with its connections, especially designed by H. Luggin for the measurement of differences of potential, such as those dealt with in experiments on polarisation. J. J. S

2257. *Accumulator Testing by Means of a Third Electrode.* **L. Jumau.** (Écl. Électr. 24. pp. 59–65, July 14, 1900.)—This paper contains a number of curves compiled from the author's own researches and those of Schoop, showing the variations on discharge and recharge of the E.M.F. and potential difference of both positive and negative electrodes relatively to a third electrode or test-plate. From these figures deductions are made as to which electrode is responsible for various features of the cell's behaviour. E. J. W.

2258. *Wehnelt Interrupter with Alternating Currents.* **B. F. Bailey.** (Elect. World and Engineer, 36. pp. 52–54, July 14, 1900.)—An account is given of various tests applied to circuits with alternating currents and containing a Wehnelt interrupter. Experiments were made with a small two-pole rotary transformer, changing from direct current at 220 volts to alternating current at 150 volts and 40 cycles per second. Curves of current and E.M.F. are given in the paper. J. J. S.

2259. *Electromagnetic Mechanism.* **R. A. Fessenden.** (Frank. Inst., Journ. 149. pp. 459–470, June; 150. pp. 62–80, July; and 106–133, Aug., 1900.)—The author considers certain points in the design of electromagnetic mechanism. The first portion of the paper is given to magnetic units and nomenclature, as adopted by the American Institute of Electrical Engineers, with the addition of such derivatives as weberivity, gilberivity, œrstedivity, and voltivity, all of which are duly defined. Examples are added, showing the application of these terms in the measurement of energy for magnetic and dielectric circuits. R. A.

2260. *Electric Conductivity of Oxides at High Temperature.* **J. Sohlman.** (Elektrotechn. Zeitschr. 21. pp. 675–676, Aug. 9, 1900.)—This paper contains a comparison of the conducting power of metallic oxides with the relative positions of the metals in the "periodic system." J. B. H.

2261. *Magnetometer.* **A. Cotton.** (Écl. Électr. 24. pp. 257–266, Aug. 18, 1900.)—An extended account of the instrument referred to in Abstract No. 1477 (1900).

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2262. *Permeability of Fused Silica to Hydrogen.* **P. Villard.** (Comptes Rendus, 130. pp. 1752–1753, June 25, 1900.)—Fused silica is, like platinum, permeable to hydrogen, but to a less extent. The substance is heated to a red heat, about 1,000°, in a Bunsen burner. The best form to give it is that of an exhausted bulb, heated in a Bunsen flame. The pressure gradually rises within the bulb, and attains several centimetres in one day. The gas which has penetrated into the bulb may be made to leave it by surrounding the bulb with a platinum case, in which air circulates, and heating again. That hydrogen is the gas which penetrates the walls of the bulb may be proved by attaching a small platinum tube to it. The gas which penetrates into the bulb can then be pumped out through the platinum at a red heat. The permeability of the silica is much increased when the substance is heated until it begins to soften. The bulb may be made to produce a musical note by blowing a current of air through it and heating it to 1,500°. The hydrogen, in penetrating the wall of the tube, is burnt to water, and the rhythmic condensation of the latter produces the note. A similar note may be produced in a heated glass tube containing a drop of water. E. E. F.

2263. *Colloidal Solutions.* **G. Bruni** and **N. Pappadà.** (Accad. Lincei, Atti, 9. pp. 354–358, June 3, 1900.)—To decide the question as to whether collodial solutions really contain the colloid in a state of solution, and only differ from ordinary solutions in that the molecules are present in complex aggregates, or whether they must be regarded as containing the colloid suspended in the liquid in a very fine state of subdivision, the author makes the following experiments. Solutions of the following colloids—silicic acid, ferric hydroxide, chromic hydroxide, ferric ferrocyanide (Prussian blue), egg albumin, and gelatine—are submitted to dialysis for varying periods, in no case less than a fortnight, the external liquid being frequently changed, especially in the first few days. In no instance is it found that any of the colloid diffuses through the dialyser, and, further, the freezing-points of the colloidal solution and of the external liquid with which it is in equilibrium show only very small differences, which are within the limits of experimental error. On carrying out vapour tension experiments by a modification of Ostwald and Walker's method, in which a current of air is passed through a series of five flasks, the first three containing the colloidal solution and the others the corresponding external liquid of the dialysing apparatus, no appreciable variations of weight are found in the last four of the flasks. The bodies known as semi-colloids, *e.g.*, dextrin and molybdic acid, pass relatively readily through a dialyser, and further give small but quite appreciable lowerings of the freezing-point proportional to the concentration; thus dextrin gives a molecular weight 1,135, corresponding to $(C_6H_{10}O_5)_7$. Between solutions of colloids and semi-colloids there exists, then, a great difference, the latter showing themselves to be merely solutions of substances of very high molecular weight. With colloids, however, these experiments indicate that the substance does not dissolve in water, but is suspended in it. This view is confirmed by applying the phase-rule to such solutions. If they are true solutions, on freezing there would be three coexisting phases—ice, solution, and vapour—the system being mono-variant; whilst in the case of a suspended solid, there would be another phase, and the system would be non-variant. That the latter is the fact is shown by there being only one temperature of freezing and not several corresponding with different concentrations. This conclusion is in agreement with that of Stöckl and Vanino, arrived at by a study of the optical properties of colloidal solutions of the metals. T. H. P.

2264. *Colloidal Solutions.* **K. Stöckl** and **L. Vanino.** (Zeitschr. Phys. Chem. 34. pp. 378–379, July 31, 1900.)—The authors adhere to their previously expressed opinion (Zeitschr. Phys. Chem. 30, 1898) that certain "colloidal" solutions of metals are merely cases of the prolonged "suspension" of very fine particles. The present note is a reply to a recent paper of Zsigmondy's [see Abstract No. 1698 (1900)], in which their conclusions were contested. F. G. D.

2265. *Supposed Isomerism of Red and Yellow Mercuric Oxide, and Surface-tension of Solids.* **W. Ostwald.** (Zeitschr. Phys. Chem. 34. pp. 495–503, Aug. 17, 1900.)—The author upholds the view that red and yellow mercuric oxide differ only in the size of the particles. The yellow oxide, being finely divided, is more soluble than the red oxide, just as small drops have a higher vapour-pressure than large drops. Experiments made on the action of mercuric oxide on potassium bromide solutions support this view. T. M. L

2266. *Velocity of Solidification and Viscosity of Supercooled Liquids.* **H. A. Wilson.** (Phil. Mag. 50. pp. 238–250, Aug., 1900.)—In a previous paper [Proc. Camb. Phil. Soc. x. Part 1; Abstract No. 778 (1899)] the author arrived at the formula—

$$v = \frac{F}{Aa}\,\frac{\theta_0 - \theta}{\theta_0}$$

for the speed of growth of crystals in a supercooled liquid, where F = latent heat of fusion of 1 grm. of the solid, θ_0 = melting-point, θ = actual temperature at interface crystal—liquid, A = force required to give unit velocity to 1 grm. of the liquid diffusing through itself, a = thickness of transition layer between solid and liquid. Regarding F and a as const., the above formula may be written $v = C\frac{s}{V}$, where s = actual supercooling, V = viscosity, and C = a const. In testing this formula a difficulty arises owing to the fact that θ is not the same thing as the temperature of the cooling bath, since heat is evolved in solidification.

In the case of the supercooled melt of salol, the speed of solidification is sufficiently small to allow of an approximate determination of θ by observing the rise of temperature indicated by a fine thermocouple immersed in the melt as the surface of solidification passes it. In this case it is found that the results of experiment are very well represented by the formula $v = C\frac{s}{V}$ Experiments were also made with benzophenone and azobenzene, but in these cases the speed of solidification was too great to admit of a direct determination of θ being made, so that it was necessary to put θ = temperature of external bath. In spite of this, the above formula was found to represent the facts fairly well. F. G. D.

2267. *Change of Weight in Chemical and Physical Reactions.* **A. Heydweiller.** (Phys. Zeitschr. 1. pp. 527–529, Aug. 25, 1900.)—Experiments are described similar to those of Landolt (Zeit. Phys. Chem. 12. p. 1. 1893), the reactions employed being (1) the action of iron on copper sulphate in neutral, acid, and alkaline solutions ; (2) copper sulphate and potash ; (3) solution of copper sulphate by water in neutral and acid solutions ; (4) mixing of copper sulphate solution and dilute sulphuric acid ; (5) action of oxalic acid on ammonia ; (6) action of barium chloride on sulphuric acid. The results obtained, combined with those of Landolt, show that the alterations of weight observed, of which the greatest is 0·229 mgrm., are, in all cases but one, decreases ; and further, are not proportional to the reacting masses. In many cases the changes are only produced in the presence of small quantities of foreign substances, more especially of acids or bases, and are hence probably due to some secondary action. T. H. P.

2268. *Influence of Chemically Indifferent Solvents on Reaction Velocities.* **N. Menschutkin.** (Zeitschr. Phys. Chem. 34. pp. 157-167, July 17, 1900.)—The results previously recorded (Berichte der Deutschen Chem. Gesell. 30. 2966, 1897), together with fresh experiments here described, are discussed with a view to elucidating the influence of various solvents on the reactions occurring between aromatic amino compounds and allyl-, or methyl-bromide, &c. The following conclusions are arrived at : Chemical reactions between organic compounds (non-electrolytes) in fluid systems take place in a similar manner, whether the compounds interact directly or in the presence of indifferent organic solvents. The regularities observed in the relations between the velocities of formation of the organic compounds examined depend on their chemical structure, and are observed both in the presence and in the absence of indifferent solvents. The study of such relations is more easily carried out in the presence of solvents. In the case of aromatic compounds exhibiting side-chain isomerism, the relative magnitude of the reaction velocities of the different isomers frequently depends on the nature of the solvent employed. N. L.

2269. *Velocity Constants of the Formation of Simple Ethers.* **W. Sagrebin.** (Zeitschr. Phys. Chem. 34. pp. 149-156, July 17, 1900.)—Experiments are described on the formation of ethers by the action of various alcohols on ethyl benzene-sulphonate. When one molecule of the sulphonate is used for 15 molecules of the alcohol the formation of the ether becomes a monomolecular reaction. The velocity constants are greatest for the primary alcohols of the fatty series, the value for methyl alcohol being the highest. In the case of the higher alcohols the constant is smaller, and diminishes regularly with the introduction of side-chains and with the greater or less distance of the hydroxyl group. The magnitude of the constant depends both on the structure of the carbon chain of the alcohol and on the influence of the same alcohol as a liquid medium. N. L.

2270. *Influence of the Medium on Reaction Velocities.* **G. Buchböck.** (Zeitschr. Phys. Chem. 34. pp. 229-247, July 17, 1900.)—The author has investigated the decomposition of thiocarbonic acid in aqueous solutions of organic and inorganic acids, various salts, &c. The conclusion is arrived at that the velocity of decomposition in such aqueous, isomotic solutions as are in equilibrium as regards the thiocarbonic acid is inversely proportional to the internal friction of the solutions. This result is shown to be in accordance with van't Hoff's theories. N. L.

2271. *Colour of Bromine and Iodine Compounds as Affected by Low Temperatures.* **J. H. Kastle.** (Chem. News, 82. pp. 90–91, Aug. 24, 1900; Amer. Chem. Journ. 23. No. 6.)—It is suggested that the characteristic red, orange, or yellow colour of bromine and iodine compounds may be accounted for by the supposition that such compounds are slightly dissociated, even in the solid state, so that the colour observed is that of the halogen itself. If this theory is correct, the colour of the halogen compounds should become lighter in tint, if not altogether white, on cooling to very low temperatures. Experiments with liquid air show that this is the case, for at $-190°$ iodoform becomes nearly white, lead iodide assumes a pale sulphur yellow tint, mercuric bromide becomes white, &c. N. L.

2272. *Heat Generated by Fibrous Substances when Wetted.* **L. Cobbett.** (Cambridge Phil. Soc., Proc. 10. pp. 372–376, Aug. 13, 1900.)—A thermometer wrapped round with a thick layer of dried filter paper rose to a maximum temperature of 132° C. when placed in a current of steam at 100° C. Similar results are obtained with cotton, silk, and wool, but asbestos produces no such effect, and it is suggested that the rise of temperature is due to the heat of combination of the water with the material of the fibre. A thermometer surrounded by asbestos or organic fibres remains at 100° C. for a considerable time when heated in a current of superheated steam, owing to the presence of moisture in the fibre. T. M. L.

2273. *Krypton.* **A. Ladenburg** and **C. Krügel.** (Preuss. Akad. Wiss. Berlin, Sitzb. 33. and 34. pp. 727–728, July 5, 1900.)—The authors have prepared Krypton from liquid air and find that its molecular weight is 59·01 and that there is about 0·00002 per cent. in the atmosphere. S. R.

2274. *Vapour-pressures of Hydrocarbons.* **B. Woringer.** (Zeitschr. Phys. Chem. 34. pp. 257–289, July 31, 1900.)—From the vapour-pressure curves of a series of sixteen aromatic and fatty hydrocarbons, the following laws are derived: (1) The difference between the boiling-points of any two members of a homologous series increases with the pressure. (2) The vapour pressure curves of two homologous substances have always relative positions such that the differences between the elevations of the boiling-point for the same increase of pressure form a rectilinear hyperbola. (3) The higher the pressure the more nearly do homologues obey Dalton's law, which states that by displacing the vapour-pressure curves parallel to the axis of temperature, they may be brought into coincidence. (4) The higher two homologues are in a series the more nearly does the hyperbola approach the limiting case of two straight lines. (5) The successive differences of boiling-point at constant pressure in a homologous series are in arithmetical progression, either increasing or diminishing with the pressure. (6) In all cases in which higher homologues are formed by the lengthening or branching of the side-chain of the benzene it is found that the elevation of boiling-point per CH_2 becomes smaller as the molecular weight increases. (7) When homologous compounds are formed by the addition of similar radicles to the benzene nucleus, the elevations of boiling-point thus produced are at the same pressure approximately equal, but diminish with the pressure. (8) In the case of aromatic position isomerides, the highest boiling-point is possessed by the compound in which the two substituent groups are adjacent. (9) All the laws holding for the normal boiling-points of isomeric compounds are obeyed at lower pressures. (10) Of isologous compounds at all pressures the aromatic are less volatile than the aliphatic derivatives; and of the former class, those which have most side-chains and of the latter those which are the most saturated, are the least volatile. T. H. P.

2275. *Iron and Steel from the Standpoint of the Phase Rule.* **H. W. B. Roozeboom.** (Zeitschr. Phys. Chem. 34. pp. 437–487, Aug. 17, 1900.)—The experimental results of Roberts-Austen [see Abstract No. 238 (1900)] are treated from the standpoint of the author's theory of the formation and transformation of mixed crystals [Abstracts Nos. 678 and 679 (1900)] which has been verified in the case of a number of simple mixtures [Abstracts Nos. 680, 1821, 1822, and 1700 (1900)].

1. *Solidification-phenomena.*—The eutectic-point for iron and carbon is at 1,130° in a mixture containing 4·3 per cent. C. The carbon probably separates as pure graphite, but the iron separates in the form known as "martensite," as a solid solution of carbon and iron containing a larger proportion of iron than the liquid solution from which it separates; the limit of solubility of carbon in martensite at the eutectic-point is about 2 per cent. A melt containing under 2 per cent. C. therefore gives only martensite on solidification; one containing between 2 per cent. and 4·3 per cent. gives at first martensite, and when the eutectic temperature is reached a deposit of martensite containing 2 per cent. C., and graphite in the ratio of 97·7 per cent. to 2·3 per cent., the temperature remaining constant till the whole is solid; one containing more than 4·3 per cent. C. behaves similarly but deposits graphite first and then an eutectic mixture of martensite and graphite.

2. *Changes in solid mixtures with more than 2 per cent. C.*—The solubility of carbon in martensite appears to decrease with temperature, and on cooling from the eutectic-point (1,130°) where the solubility is about 2 per cent. to 1,000°, where the solubility is about 1·8 per cent., a further amount of graphite (called "temper-carbon") separates, and a conglomerate of graphite with a martensite containing 1·8 per cent. C. results in all cases where the total proportion of carbon in the mass is above 1·8 per cent. At 1,000° this conglomerate is converted at a uniform temperature into a mixture of "cementite" (Fe_3C) with either graphite or martensite according as the proportion of carbon is greater or less than 6·6 per cent. These changes would be considerably modified by cooling rapidly instead of slowly, and the chief effect of rapid cooling would be that a melt containing 2 to 6·6 per cent. C. would probably pass direct to a mixture of martensite and cementite without any intermediate separation of graphite. The transition-point for cementite $\rightleftarrows$ martensite + graphite would probably be best determined by heating pure cementite. From 1,000° to 690° the solubility of carbon in martensite falls again from 1·8 to 0·85 per cent. and carbon is deposited in the form of cementite, as was shown both by Osmond and by Roberts-Austen. At 690° carbon no longer forms a solid solution with iron and the remainder of the martensite changes abruptly into a fine conglomerate of "ferrite" (pure iron) and cementite, which is known as "perlite."

3. *Changes in solid mixtures with less than 2 per cent. C.*—These mixtures solidify to a homogeneous martensite and their homogeneous character can be preserved by rapid cooling. If there is more than 0·85 per cent. C. the martensite becomes saturated with carbon at some temperature between 1,000° and 690°, and deposits cementite until at 690° the remainder of the martensite passes abruptly into perlite (ferrite and cementite). If, however, there is less than 0·85 per cent. C. the martensite deposits iron and not carbon

or carbide on cooling. The γ-iron of martensite, which forms a solid solution with carbon, passes at 890° (the Ar$_3$ point) into β-iron and at 770° (Ar$_2$) into magnetic α-iron, neither of which dissolve carbon to any appreciable extent. The martensite deposits β-iron between 890° and 770° if the proportion of carbon lies between 0 and 0·35 per cent. and α-iron between 770° and 690° if the carbon lies between 0·35 and 0·85 per cent., in much the same way as ice separates from an aqueous salt solution; at 690° a martensite containing 0·85 per cent. C. is saturated both with ferrite (α-iron) and cementite (Fe$_3$C) and passes into perlite, this temperature corresponding with the eutectic-point of ice and salt.

The behaviour of iron-carbon mixtures is also discussed on the assumption that other modifications, such as "Austenite," exist, and a discussion is given of the state of the dissolved carbon and its diffusion through the solid iron.

T. M. L.

2276. *Thermodynamics of the Voltaic Cell.* **H. S. Carhart.** (Phys. Rev. 11. pp. 1–18, July, 1900.)—After a theoretical introduction in which the author obtains the well-known Helmholtz equation, he proceeds to describe measurements of the Peltier effects at the metal-liquid junctions in the Daniell cell. The method of procedure was as follows: The solutions of zinc and copper sulphates were chosen of such strengths that their specific conductivities were practically equal. The current was allowed to flow in one direction for a certain time and the difference of temperature between the two metal-liquid junctions measured by a thermocouple. This difference was then corrected for the disturbing effects of conduction and radiation. The current was allowed to flow in the reverse direction (after equalisation of temperature) until the same quantity of electricity had passed, and a new (corrected) difference of temperature obtained. The mean of these two differences gives the true difference corrected for loss of heat by radiation and conduction, and for unsymmetrical effects due to concentration-changes at the electrodes and inequalities in the Joule heat developed in the neighbourhood of the electrodes. The value so found experimentally agreed very well with the value calculated from the specific heats of the solutions and the known constants of the cell.

F. G. D.

2277. *Graphical Thermodynamics of Electrochemical Processes.* **F. Haber.** (Phys. Zeitschr. 1. pp. 361–371, June 2, 1900.)—This is an exposition of the graphical method employed by Luggin in his lectures on theoretical electrochemistry, wherein the free energy and temperature are chosen as co-ordinates, the heat of the reactions being taken to be independent of the temperature when the processes occur without work being done, and the free energy being taken to be a linear function of the temperature. The action in Bredig and Knüpffer's thallium cell is specially considered, and Bodländer's views on the relation of E.M.F. to solubility are graphically explained. R. E. B.

2278. *Theory of Transition-cells of the Third Type. I.* **E. Cohen.** (Zeitschr. Phys. Chem. 34. pp. 179–186, July 17, 1900.)—The E.M.F. of a transition-element of the third type, which depends on the conversion of a metastable into a stable hydrate of a salt, is given by the equation $E = q\frac{P-T}{p}$, where q is the heat developed in the change, P the absolute temperature of the transition-point, and T the absolute temperature of the cell; the temperature coefficient, $\frac{dE}{dT}$, is $-\frac{q}{P}$. The value of q has been determined in the case of the hydrates $ZnSO_4.7H_2O$ and $ZnSO_4.6H_2O$ from Thomsen's numbers to be − 3609 calories at 18°, whilst a direct determination at 39° gave $q = -3752$ calories. From this value the temperature coefficient is calculated to be − 0·52 millivolts, whilst Jaeger's values for the E.M.F. of Clark cells containing the two hydrates gave $\frac{dE}{dT} = -0·50$ millivolts at 39°, showing a very satisfactory agreement between the calculated and observed values. T. M. L.

2279. *Calculation of the Conductivity of Aqueous Solutions Containing Hydrochloric and Sulphuric Acids.* **J. Barnes.** (Nova Scotian Inst., Trans. 10. pp. 129–138, 1899–1900.)—The conductivities of dilute mixtures of hydrochloric and sulphuric acids have been calculated according to the method of MacGregor (Trans. N.S. Inst., 9, 101, 1895–6) from those of the simple solutions and have been compared with the observed conductivities. The differences do not exceed 0·5 per cent. when the concentrations of the acids are not greater than those of normal solutions, and the assumption made, that in these dilute solutions the sulphuric acids dissociates into 2H and SO_4, is therefore justified [see also Abstract No. 988 (1900)]. T. M. L.

2280. *Depression of the Freezing-point by Mixtures of Electrolytes.* **J. Barnes.** (Nova Scotian Inst., Trans. 10. pp. 139–161, 1899–1900.)—The specific molecular conductivities of potassium and sodium chlorides and of hydrochloric acid were determined at 0°, and the values of $\frac{\mu_{18} - \mu_0}{\mu_{18}}$ were found to have almost constant values, viz., 0·366, 0·381, and 0·301 respectively. The observed molecular depressions of the freezing-point were 1·86, 1·90, and 1·85 respectively. The ionisation-coefficients of the mixtures were calculated by MacGregor's method, and hence the depressions of the freezing-point were ascertained. These were compared with the observed depressions in mixtures of potassium and sodium chlorides, sodium chloride and hydrochloric acid, and in mixtures of the three chlorides, and the deviations were found to be in all cases within the limits of experimental error. T. M. L.

2281. *Solubility of a Mixture of Salts Possessing a Common Ion.* **C. Touren.** (Comptes Rendus, 131. pp. 259–261, July 23, 1900.)—The author in continuation of previous work [see Abstracts Nos. 1527 and 1706 (1900)] has determined the solubility of potassium nitrate in solutions of potassium carbonate, and potassium bicarbonate respectively. If the results be plotted as curves in which the ordinates represent the number of K-ions proceeding from the nitrate and the abscissæ the number of K-ions proceeding from the carbonate or bicarbonate (assuming complete ionisation) it is found that the curves so obtained coincide pretty closely with the corresponding curve obtained from the chloride and nitrate so long as the concentrations are not too high. Above a certain limit there ceases to be any coincidence owing to variation in the degree of ionisation. F. G. D.

2282. *Electromotive Force and Optical Constants of Chromium.* **F. J. Micheli.** (Archives des Sciences, 10. pp. 122–131, Aug., 1900.)—The passivity of iron, which appears to be due to the formation of a film of oxide, is accompanied by a change in the optical properties of the surface as indicated by the plane of polarisation of a reflected ray of polarised light. Active chromium, however, exhibits *no* change when converted into passive chromium by immersion in nitric acid, and it is therefore concluded that no film of oxide is formed in this case. By heating with fused zinc chloride, chromium becomes covered with a layer of oxide which can be detected by the optical method, but this is accompanied by increasing activity and the chromium can also be brought into the passive state by immersing in nitric acid without disturbing the film, showing that the film of oxide has no influence on the active or passive state of the metal.

Whereas Hittorf and Ostwald state that active chromium gradually becomes passive on exposure to the air, the author found that passive chromium gradually became active. [*Cf.* the following Abstract.]

T. M. L.

2283. *Passive State of Metals.* **W. Hittorf.** (Zeitschr. Phys. Chem. 34. pp. 385–402, Aug. 17, 1900.)—The combination, Fe | NO_3Na, CrO_4H_2 | Pt has an E.M.F. of 1·82 to 1·84 volts on open circuit, as measured by a quadrant electrometer; with a Siemens galvanometer the E.M.F. gradually decreased owing to the passage of the current, and when short-circuited the E.M.F. fell almost instantly to 0·1 volt, the relatively large current causing the iron to assume the passive state very rapidly. The passive state is, however, unstable, and on open circuit the E.M.F. rose again in twenty minutes to 1·82 volts; the iron also becomes active again when washed and dried in the air, and it is therefore concluded that the passive state cannot be due to a film of oxide since this would not be removed by this treatment. The passive state is assumed still more rapidly if the current through the cell is increased by an external E.M.F., and under these conditions the iron is no longer attached at all by the $-NO_3$ ions, but oxygen and nitric acid are formed; under similar conditions chromium yields chromic acid and not free oxygen; with no additional E.M.F. iron never becomes passive in *acid* solution. If a solution of copper or silver nitrate is used in place of sodium nitrate, the iron immediately becomes inactive, but addition of nitric acid restores the activity and causes the immediate precipitation of copper or silver, unless a strong current is kept passing through the cell. A momentary reversal of the current immediately renders the iron active. Potassium bichromate in place of sodium nitrate gave 0·95 volt, falling to 0·17 when short-circuited for seven minutes, and sodium acetate gave 1·49 volts, falling in a few minutes to 0·15 volts when short-circuited; but with sodium sulphate the passive state could only be realised with an external E.M.F. of 2 volts, and disappeared at once on open circuit. Iron is passive in strong nitric acid, but this state does not persist when removed from the acid and in acid of sp. gr. 1·2, it can only be kept from dissolving as the anode for a large current; similarly chromic acid requires a large current to protect the iron, and in dilute sulphuric acid the solution of the iron, which cannot be stopped when once started, is only prevented by an external E.M.F. Sodium hydroxide in place of sodium nitrate gave an E.M.F. of 1·59 volts, falling in a few minutes to 0·16 volt when short-circuited, owing to the iron becoming passive.

In addition to chromium and iron, nickel and cobalt possess the power of assuming the passive state, though in a much smaller degree. Silver and lead also behave similarly when in contact with sulphate solutions. [*Cf.* preceding Abstract.]

T. M. L.

2284. *Decrease of Osmotic Pressure by Ion-charges.* **V. v. Türin.** (Zeitschr. Phys. Chem. 34. pp. 403–408, Aug. 17, 1900.)—Owing to the mutual attraction of the ions the osmotic pressure in a spherical vessel is reduced according to the equation—

P (dynes per sq. cm.) = $1{\cdot}158 \times 10^{11}.k.D^{-1}.q.a^{-1}$, where D is the dielectric constant of the solution, k the concentration, $\pm q$ the charge on each ion, and a the radius of the sphere. T. M. L.

2285. *Electrolytic Potassium Chlorate.* **A. Brochet.** (Ind. Électrochim. 4. pp. 41–43, April, 1900; from L'Électro-Chimie, p. 55, 1900.)—A continuation of his investigations [Abstract No. 691 (1900)] has lead the author to the following conclusions: In cold, practically neutral (slightly alkaline or acid) solutions of potassium chloride, the chlorate is always a secondary product, the only primary product of the electrolysis being hypochlorite, whose reduction can be prevented by the addition of bichromate, after E. Müller's method. A certain portion of the hypochlorite is then, by the generation of oxygen, transformed into chlorate, in a manner that is uncertain; there seems to be no electrolysis of water. The transformation is of a complex nature, and the author appears to ascribe an essential part to the bichromate. In hot [there is evidently a misprint in the paper] alkaline solutions, the conversion of hypochlorite into chlorate is more rapid but never complete. Whether or not there be a primary formation of chlorate in more strongly alkaline solutions remains undecided. On the whole, the author sides with Oettel. [See also Abstract No. 1899 (1900).] H. B.

2286. *Electrolysis of Concentrated Hypochlorite Solutions.* **A. Brochet.** (Comptes Rendus, 131. pp. 340–343, July 30, 1900.)—In continuation of previous experiments on the electrolytic production of chlorates [see Abstracts Nos. 691 and 1899 (1900)] the electrolysis of alkaline solutions of sodium hypochlorite has been studied on the same lines as before. The results are represented by curves. The proportion of hypochlorite decreases rapidly at first and then more slowly until it becomes constant, whilst the amount of chlorate increases at first rapidly and then more slowly. The kathodic reduction remains for some time constant at 97–99 per cent. and then rapidly diminishes, whilst the anodic oxidation is at first constant at about 50 per cent. and afterwards increases rapidly. The amount of alkali present has but little influence on the reduction. The general conclusion arrived at is that the electrolysis of hypochlorite solutions in its later stages resembles that of chlorides and tends towards the same limits. There is hence little hope of obtaining concentrated hypochlorite solutions by direct electrolysis. N. L.

2287. *Electrolytic Reduction of Difficultly Reducible Substances in Sulphuric Acid Solution.* **J. Tafel.** (Zeitschr. Phys. Chem. 34. pp. 187–228, July 17, 1900.)—The behaviour of caffeine was more especially studied with a view to elaborating a method which would allow of the systematic regulation of the experimental conditions and afford a general method for the preparation of compounds by electrolytic reduction. The reduction of caffeine in sulphuric acid solution is only possible when the kathode consists of a material (lead or mercury) showing a high kathode potential. The disturbances often observed in reductions are found to be due to the contamination of the kathode by traces of foreign metals, and are best avoided by coating the surface of the electrode with lead sponge, electrolytically deposited. The reduction is hastened by a rise of temperature, but only to a slight extent. The current yield, within certain limits, is nearly proportional to the current. For equal concentrations of caffeine and equal currents per litre of liquid at the kathode ("current concentration") the current density has relatively little influence on the course of the reaction, the reduction increasing slightly as the current density diminishes. In apparatus of similar construction but different size the reaction follows the same lines provided the initial concentration of the substance, the current concentration, and the relation between the surface of the kathode and the volume of the kathode liquid are the same in each case. N. L.

2288. *Electrolytic Estimation of Lead.* **C. Marie.** (Chem. News, 82. p. 51, Aug. 3, 1900; from the Bull. Soc. Chim. 23. No. 12.)—In order to estimate lead in such insoluble compounds as the chromate and sulphate, the substance is dissolved in nitric acid with the aid of ammonium nitrate, the liquid diluted, and the electrolysis carried out at 60–70° in the usual manner. Five grammes of ammonium nitrate should be used for 0·3 gm. of lead sulphate, and the diluted solution should contain 10 per cent. of nitric acid. The process is applicable to lead glass, which is subjected to a preliminary treatment with a mixture of sulphuric and hydrofluoric acids. N. L.

2289. *Electrolytic Estimation of Cadmium.* **D. Balachowsky.** (Comptes Rendus, 131. pp. 384–387, Aug. 6, 1900.)—Pure, adherent deposits of cadmium, in a state suitable for washing and weighing, may be obtained by dissolving 1·5–2 grammes of the cadmium salt in 150 c.c. of water, adding 7–10 c.c. of nitric acid, and electrolysing in a copper-coated Classen capsule at 60°. The E.M.F. may rise from 2·8–3·5 volts, and the current density from $ND_{100}=0{\cdot}4$–$0{\cdot}6$ ampere. Cadmium may also be estimated by the process advocated in the case of bismuth [see following Abstract], the electrolysis being carried out at 40–60° in a roughened capsule and 2–4 per cent. of urea, formaldehyde, or acetaldehyde being added to the solution. N. L.

2290. *Electrolytic Estimation of Bismuth.* **D. Balachowsky.** (Comptes Rendus, 131. pp. 179–182, July 16, 1900.)—The bismuth salt, to the extent of 0·5–0·8 gms., is dissolved in 5–6 c.c. of nitric acid diluted with 150 c.c. of water, 3–4 gms. of urea added, and the liquid electrolysed for six hours at about 60°, using an E.M.F. of 1·5–1·9 volts, and a current density of 0·03–0·04 ND_{100}. By operating in this manner closely adherent deposits of metallic bismuth are obtained which may be readily washed and weighed. The absence of large quantities of chlorides, bromides, or iodides is essential, and unpolished platinum electrodes should be used. N. L.

2291. *Feeding Apparatus for Electrolytic Cells.* **R. Girouard.** (Elektrochem. Zeitschr. 7. pp. 111–113, Aug., 1900.)—A description, with figure, of an arrangement for conveying liquid at a regular rate from a reservoir to the electrolytic cell; the liquid is caused to pass through a capillary tube, from which it issues in drops, so that there is no electrical contact between the liquid in the reservoir and that in the cell. T. H. P.

2292. *Electro-chemical Industry in France.* **L. Guillet.** (Génie Civil, 37. pp. 146–149, June 30; 172–173, July 7; 186–190, July 14; 219–220, July 21; 229–231, July 28; 254–256, August 4, 1900.)—This review of the progress of the chemical industry in France in recent years covers the whole extent of the industry, but only the portions relating to electro-chemistry and electrometallurgy are referred to in this Abstract.

Caustic soda is produced by two companies, using the Greishem process, and the Outhenin-Chalandre process respectively. The works are located at Lamothe and at Montiers. The former produces 2,500 tons per annum. Alkalies and bleaching powder are produced by the *Société Fives-Lille* at Bozel, in Savoy, where 8,000 H.P. is available. The *Société d'Electro-chimie* produces potassium permanganate, ammonium persulphate, chlorates and perchlorates at St. Michel. The second of these is obtained by electrolysis of ammonium sulphate. It is used in bleaching operations and in photography. Chlorates and perchlorates are also made by Berges, Corbin & Co., at their works at Chedde, in Savoy. The total French output of chlorate is estimated to be 8,850 tons, of which total 8,000 tons is produced by the two electrolytic works named above. Perchlorate of ammonium is a new chemical, used in preparing mining explosives. The manufacture of phosphorus by the electric furnace method is about to be introduced into France. Hitherto the French production of this chemical has been solely due to the operation of the old chemical reduction process. Calcium carbide is produced by eight factories situated in the eastern districts of the country. The factories are at Sechilienne, Epierre, St. Michel, Giffre, N. D. de Briançon, Bellegarde, Froges and St. Beron. In the aggregate these factories have at their disposal 14,400 H.P., for carbide production, but the whole of this power is not yet used in the manufacture. J. B. C. K.

2293. *Electrolytic Drilling and Slotting of Metals.* **S. Cowper-Coles.** (Elect. Rev. 47. pp. 131–132, July 27, 1900.)—The advantages claimed for this method are that hard-tempered plates can be drilled in any position with any shape of hole without removing the temper. The apparatus in its simplest form consists of a nozzle, the narrow end of which is the shape of the desired hole. The nozzle is provided with inlet and outlet pipes for the electrolyte, and with a baffle plate to facilitate circulation. A metal kathode rod is also provided. The nozzle is pressed against the plate which is to be drilled, and an electric current is passed through the electrolyte, using the plate itself as anode. Either sulphuric acid solution, or brine, may be used as electrolyte. The article is illustrated. J. B. C. K.

2294. *Intermittent and Continuous Carbide Furnaces.* **O. Frölich.** (Zeitschr. Elektrochem. 7. pp. 1–10, July 5, 1900.)—This is a reply to Carlson's paper [see Abstract No. 1129 (1900)] in a previous issue, the author pointing out that in Carlson's comparison of the two classes of furnaces (to the detriment of the continuous furnace), he had taken as his type of continuous furnaces those in which the carbide is tapped out in the fluid condition, whereas in the better class of furnace of this type, such as that of Horry, and of Siemens and Halske, this is not the case. Applying Carlson's arguments and calculations one by one to the furnaces of the last-named type, he shows that many of Carlson's deductions must be modified or reversed. W. G. M.

2295. *Electric Furnaces for Calcium Carbide.* **R. Memmo.** (Elettricità, Milan, 19. pp. 466–470, July 28, 1900.)—Furnaces may be divided into two classes: those in which the carbide is maintained liquid, and withdrawn from time to time during the action of the furnace from an orifice at the bottom; and those in which the carbide forms a solid block, which is taken out after partial cooling of the furnace. The author compares the advantages and disadvantages of the two types, summing up as follows;—

The former type wastes heat in maintaining the carbide liquid, and must always be worked at full power; it can, however, be worked continuously, and in this respect saves the heat lost in cooling the block furnaces. The product is impure but homogeneous, and gives a slow and regular evolution of gas.

The block furnaces are very efficient in action, but the extraction of the block occasions waste of heat. They can be worked at low charges with but slight loss of efficiency. The attendance necessary during action is small, but the blocks after extraction require considerable working. The carbide is very rich in gas, but not homogeneous, and gives a violent action with water.

G. H. B.

2296. *Electrolytic Zinc and Utilisation of Anode Gases.* **J. Rontschewsky.** (Zeitschr. Elektrochem. 7. pp. 21–25, July 12, and 29–32, July 19, 1900.)—This is an account of a series of experiments made with a view to utilising the oxygen given off at the insoluble anode when submitting solutions of zinc sulphate to electrolysis. For the simultaneous production of, for instance, peroxide of lead and metallic zinc, the author employs an anode of the former metal, with the addition of a variable percentage of sodium chloride, in order to provide the necessary acid suitable for rendering the lead soluble. A number of trials were made in order to obtain the best results with regard to temperature, concentration, current density, and rate of circulation of liquid. Other experiments are also given with the view to producing lead chromates. In all cases the zinc deposited was of a coherent and crystalline character.

O. J. S.

2297. *Barrel Method of Nickel Plating.* **G. Dary.** (Électricien, 20. pp. 49–50, July 28, 1900.)—The cycle and motor-car industries have greatly increased the demand for nickel-plated articles. The older method of plating, which involved the handling of each separate article, is no longer practicable for the innumerable small articles, such as nuts, bolts, &c., which now require to be nickel plated.

An English patent, owned by the Electrolytic-plating Apparatus Co., has solved the economic difficulty presented by the plating of these small objects. The preliminary treatment involves the usual boiling with strong potash solution, rinsing in water, and immersion in a nitric acid bath; but these and the after electrolytic deposition of the nickel, are all carried out in the one piece of apparatus. This consists of a perforated wooden barrel, mounted so that it may be rotated at any desired speed in the tanks containing the various cleaning and depositing solutions. The barrel and its mountings are suspended by a rod which rests on the tanks, and the whole can be raised or lowered by means of pulleys. The method of working is as follows: The barrel is filled one-half or two-thirds with the articles, and is then lowered into the cleaning or depositing solutions. The speed of rotation varies according to the form of the articles to be plated—a speed of fifty-five revolutions per minute being found the best for certain forms. The electrical contact between the articles in the barrel and the negative leads is effected by means of the metal rod which carries the barrel and the trunnions on which it revolves. From the latter metallic strips run along the interior of the barrel, and thus make contact with all the articles which it contains.

A current of 10 amperes at 6 volts pressure will plate 20 kgs. of metallic objects in four hours, the barrel used for such a charge being 0·75 metre in length. Sawdust is used to dry the articles, after they have been thoroughly washed with water. The cost of nickel-plating by this process lies between 0·80 and 2·50 francs per kg., according to the form of the articles requiring to be plated. J. B. C. K.

2298. *Electrolytic Cleaning of Metals.* **J. Reyval.** (Écl. Électr. 24. pp. 91–92, July 21, 1900.)—After a reference to the disadvantages of the older methods of preparing metal surfaces for electroplating and other purposes, and to the previous attempts to make use of electrolysis for this work, the author gives a brief description of the method patented by the "Vereinigte Elektricitäts Aktien Gesellschaft" of Vienna (French Patent, 292333 of 1899). This method is applicable to all metals. A salt of one of the alkali metals is used to make up the electrolyte, and carbon, or a metal unattacked by the electrolyte or its constituent ions, is used as the second electrode. Aluminium and zinc are connected as kathodes in such a solution, while iron, copper, or alloys of the latter metal are made the anodes. In the former case an aluminate or zincate is formed at the kathode on passing a current through the solution, and as the solution of this salt diffuses into the bath it meets the free acid formed at the anode, and a precipitation of zinc or aluminium hydrate occurs. In the latter case, an alkaline hydrate is formed at the kathode, and this diffusing into the bath produces a precipitate of the iron or copper dissolved at the anode. In each case, therefore, the electrolyte is *regenerated*, while the metal dissolved is collected as a hydrate from the bottom of the bath. In the case of costly metals, such as copper, this recovery of the metal as hydrate is a decided advantage. For cleaning steel sheets before galvanising, a solution of sodium sulphate is used as electrolyte, and thicker sheets of iron are used as kathodes. A current density of 140 amperes per sq. metre can be obtained with an E.M.F. of between 4 and 8 volts. Practical tests have proved the method to be rapid and economical. J. B. C. K.

REFERENCES.

2299. *Extraction of Oxygen from the Air.* **G. Claude.** (Comptes Rendus, 131. pp. 447–450, Aug. 20, 1900.)—The author refers to the commercial importance of obtaining air rich in oxygen, and the possibility of doing this without expenditure of energy. He shows that a mixture of nitrogen and oxygen containing 50 per cent. of the latter would already effect a great saving with respect to the quantity of diluting nitrogen. He has tried the effect of using various solvents at low temperatures, but the small difference between the solubilities of nitrogen and oxygen showed that a process based on this method would be quite useless. F. G. D.

2300. *Liquid Crystals.* **R. Schenck.** (Phys. Zeitschr. 1. pp. 409–413, June 23, and 425–428, June 30, 1900.)—A *résumé* of the researches made up to the present on liquid crystals. T. H. P.

2301. *Electro-chemistry in a Dye and Print Works.* **A. E. Sunderland.** (Electrician, 45. p. 703, Aug. 31, 1900. Paper read before the Society of Dyers and Colourists at Bradford Technical College.)—The author first describes the principles underlying the oxidation or reduction of organic dye products in the electrolytic cell, and then describes in detail some of the methods worked out by Goppelsroeder in 1886, for applying these principles in practice. The author's own experiments upon the Diazo compounds are next dealt with, and an electrolytic method for producing the water-mark or "Moire" effects, upon piece goods is described. The paper closes with a brief account of the Schreihage method of hot pressing, which is simply an application of resistance heating to this special problem. J. B. C. K.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

2302. *Single Cylinder Farcot Engine at the Paris Exhibition.* (Engineer, 89. p. 664, June 29, 1900.)—That a 1,000 H.P. engine should in these days of high speed multiple expansion engines be built with a single cylinder, is a significant fact, and emphasises the point that so far as thermal efficiency is concerned, there is not much to choose between the two systems.

The cylinder is 39·37 inches diameter, and the engine has 4 ft. 5 in. stroke, and is designed to run at 78½ to 79 r.p.m. The steam consumption is as follows :—

Cut-off.	B.H.P.	Steam for I.H.P. hour.
$\frac{1}{10}$	700	13·5
$\frac{2}{10}$	1,020	14·4
$\frac{3}{10}$	1,230	16·4

As the boiler pressure is only 85 lbs. per square inch this is a very fair record.

The two-phase alternator driven by this engine is nominally 750 kilowatts [see Abstract No. 2318 (1900)]. The crank shaft is 15·75 inches diameter at the exciter bearing, and is swelled to 25·6 inches at the centre, where the alternator flywheel is keyed on. Corliss valves are used, and they are placed in the covers at either end of the cylinder. The trip gear employed to work the valves is that usually employed by the Farcot firm, all the wearing parts being made of hardened steel. L. S. R

2303. *Superheated Steam.* **P. Schou.** (Northern Soc. Elect. Engin., Proc. 5. pp. 21–27 ; Discussion, pp. 27–30, 1899.)—Schmidt, of Cassel, first introduced complete plant working with superheated steam. Over two hundred plants are now running most successfully on his plans. One 750-H.P. plant has been running in a rolling mill for three and a half years, consuming 8·75 lbs. of steam per I.H.P. hour, and is now to be followed by a 4,000-H.P. plant in the same works. Tests made in Ireland on a 70-H.P. engine gave 10·2 lbs. of steam and 1·4 lbs. of coal per I.H.P. hour. The two great difficulties were to find tubes that will stand the excessive heat of the superheater and to ensure the proper lubrication of the engine.

The Schmidt engine has the following advantages : (1) H.P. cylinders require no jackets ; (2) heat absorbed by the H.P. cylinder walls during admission is not lost but goes to heat the receiver ; (3) L.P. cylinder is heated by receiver steam ; (4) H.P. piston is cooled inside by receiver steam ; (5) only one stuffing box is in contact with receiver steam.

For double-acting steam engines Schmidt has a novel idea of mixing the two classes of steam, superheated and saturated, and the governor regulates the supply of these two classes of steam in connection with the cut-off. The arrangement for effecting this is fully described.

The superheater is composed of a series of lap welded coils from 1 inch to 2 inches diameter, according to the size of the superheater, and they are bent into coils or zigzag to suit the existing circumstances. They are heated either direct by the escaping flue gases or independently by an auxiliary furnace.

Schmidt also fits an economiser behind the superheater to still further reduce the temperature of the escaping gases. Distilled water only is used in this economiser to avoid corrosion and cleaning, and it is used to heat the feed water supplied to the boiler. As the distilled water which leaves the feed-heater is hot it does not cause the gases coming in contact with the economiser tubes to condense and deteriorate the tubes. It is claimed that an economy of 20 to 25 per cent., even on the best compound engine, can be obtained by the use of this kind of heater. Two large Schmidt superheaters are now being put down in Manchester for electric traction purposes.

Discussion.—**Raworth** pointed out that with superheated steam, joints which would leak with saturated steam remained tight when superheated steam was used, and Mr. Schmidt confirmed this statement. **Mannock** had used a slight superheater for many years, but had experienced great difficulty with the lubrication and corrosion of the tubes. **Browett** pointed out that cost of fuel for generating current was between ½d. and 1d. per unit, and that the saving of one-third of this by this superheater was very little on total cost, and might be balanced by extra charge for maintenance of superheater. **A. B. Mountain** had seen great difficulties in use of superheated steam with piston-rods, packing, and valves in double-cylinder engines, and mentioned that Robey & Co. had successfully employed the mushroom type of valve some years ago. L. S. R.

2304. *Production and Utilisation of Superheated Steam.* **R. S. Hale.** (Eng. Mag. 18. pp. 722–728, Feb., 1900.)—After reviewing the forms and positions of superheaters, the author concludes that in general the best position for a superheater is within the flues of a boiler, where the heat, although insufficient to overheat the tubes is yet sufficient to admit of comparatively small area of superheating surface, and is further utilised by the remainder of the boiler-heating surface. The relative advantages of different kinds of superheaters are discussed and the economy by the use of superheated steam is given. The author believes steam of 500 lbs. pressure superheated to 650° F. to be one of the probabilities of the future. J. T. R.

AUTOMOBILISM.

2305. *Rochet Automobile.* (Locomotion Automobile, 7. pp. 422–425, July 5, 1900.)—The standard type of mechanism for motor vehicles, made by the firm of Rochet, is described with the aid of photographic illustrations.

It consists essentially of a tubular underframe to which the mechanical parts and the carriage body are directly attached, and which is supported from the front axle by a single leaf spring placed transversely to the length of the frame, and from the back axle by single leaf springs one at either side below the longitudinal frame members.

The engine is attached to the frame immediately behind the front axle, and drives, through a cone friction clutch, a longitudinal shaft, at the back end of which is the speed changing mechanism. From this gear, which permits of four changes of speed in the forward direction and one reverse speed, the power is transmitted through bevel gear to a transverse shaft carrying the differential gear, and at its ends sprocket pinions which drive the rear road wheel through pitch chains. The vehicle is controlled by three band brakes. The steering is on the Ackerman system, the steering wheel pivots being directly controlled from the steering-bar without the interposition of any gear, The petroleum spirit engine is a modified Daimler, and has two vertical cylinders, the pistons of which are coupled to cranks at 180°, thus securing balance of the mechanical parts at the expense of irregularity of impulse, due to both explosions taking place in one revolution. The cranks, and, as far as possible, the mechanism for actuating the exhaust valves, are enclosed in an oil-tight gear-case. The governor is of the centrifugal type, and operates on the engine by preventing the lifting of the exhaust valves. Ignition is electric, a storage battery and induction coils being carried. The cylinder bodies and heads are water-jacketed, the water being circulated by a rotary pump and passed through a cooler on its way back to the tank. The normal speed of the engine is 750 r.p.m. and the power developed from 6 to 8 B.H.P.

The speed-changing gear, which forms one of the principal features of the Rochet vehicle, consists of four pairs of spur wheels, each pair being mounted on a spindle fixed to a plate which may be rotated concentrically with the longitudinal shaft driven by the engine through the friction clutch. At the back end of this shaft is a spur wheel with which one wheel of either pair of movable wheels engages. The other wheel of each pair may, by suitable rotation of the plate be caused to engage with a spur wheel on a short shaft which drives the differential shaft through bevel gear. The special advantage claimed for this gear is that owing to the distribution of the pitch circles, the wheels roll into gear instead of engaging by side contact, with resulting diminution in wear and tear, and noise on changing speed. C. R. D'E.

2306. *Massignon's Change Speed Gear.* (Locomotion Automobile, 7. pp. 528–530, Aug. 16, 1900.)—This article describes an arrangement of belt transmission and epicycloidal gear by means of which variable speed, forward or reverse, may be imparted, from a shaft driven by a motor at constant speed, to a countershaft from which the road wheels of a motor vehicle may be driven. The arrangement illustrated has not been practically applied with success to motor vehicles. C. R. D'E.

REFERENCES.

2307. *Standard Rules for Boiler Engine Trials.* (Elektrotechn. Zeitschr. 21. pp. 352–355, May 3, 1900.)—This article gives a very complete set of rules for conducting standard boiler and engine trials, issued jointly after careful revision by the following Societies: "Verein deutscher Ingenieure," "Internationaler Verband der Dampfkessel-Ueberwachungsvereine," and "Verein deutscher Maschinenbauanstalten," and is well worth consulting by those conducting or interested in boiler and engine trials. L. S. R.

2308. *Steam Piping and Accessories.* **W. D. Ennis.** (Street Rly. Rev. 10. pp. 12–15, Jan. 15; 93–95, Feb. 15; and 135–136, March 15, 1900.)—An article containing several drawings, showing different arrangements of steam piping.

GENERAL ELECTRICAL ENGINEERING.

2309. *Practical Primary and Secondary Cells with Electrolytes of Constant Conductivity.* **E. W. Jungner.** (Elektrochem. Zeitschr. 7. pp. 102–104, Aug., 1900.)—The primary cell has the following construction: The positive electrode consists of powdered silver peroxide (so-called "ozonised" silver) mixed with a binding material to form a porous mass which is contained in a net of nickel gauze. The negative electrode is a copper net containing finely divided copper. The electrodes are arranged alternately in an ebonite vessel and are separated by thin layers of asbestos paper moistened with caustic alkali solution; the conducting wires from similar electrodes are joined together. The cell is provided with a stone cover containing holes for the escape of any gas which may be evolved by overcharging. The reactions taking place during the discharge of such an element are—

$$Ag_2O_2 + 2KOH + 2Cu = Ag_2O + K_2O + 2CuOH$$

$$K_2O + H_2O = 2KOH$$

and—

$$2\,CuOH = Cu_2O + H_2O$$

the whole action being expressed by the equation—

$$Ag_2O_2 + 2\,KOH + 2Cu = Ag_2O + 2KOH + Cu_2O.$$

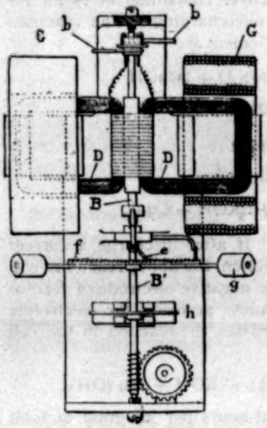
The E.M.F. developed by the cell is 0·93 volt. If, after discharge, a current be passed through the cell in the opposite direction, the above reactions will take place in the reverse sense. By making the negative electrode of ferrous hydroxide and the positive of hydrated manganese peroxide, the electrolyte will still remain unchanged when a current passes, the reaction in the cell being expressed by—

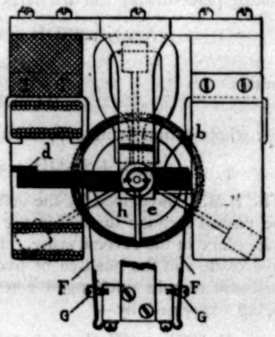
$$Fe\,(OH)_2 + KOH + Mn\,(OH)_4 = Fe\,(OH)_3 + KOH + Mn\,(OH)_3.$$

Such an accumulator gives out 40 to 50 watt-hours per kilogram of total weight, the power being 5 to 10 watts. The internal resistance is very small, owing to the layer of liquid between the electrodes being very thin. The electrodes have a long life since the small changes of volume during charging or discharging have only a slight effect on their compactness. As no secondary reactions can take place in the cells they can be used almost indefinitely without diminution of capacity. Finally, charging or discharging may be interrupted or carried too far without injury to the accumulator which is besides almost uninfluenced by dampness or changes of temperature and requires but little attention. T. H. P.

2310. *Electromagnetic Ticket Printing and Delivering Device.* **F. Krull.** (Elekt. Runds. 17. pp. 193–194, July 1, 1900.)—In this device there is an ebonite coin-chute having three pairs of contacts which are successively connected together by the coin as it falls. The first two sets serve to complete the circuits of two electromagnets arranged respectively on the ends of an oscillating balance-beam and of stationary electromagnets arranged opposite the moving electromagnets, in such a manner that the balance-beam is oscillated first in one and then in the other direction. This motion is utilised in reciprocating a slide which pushes the lowermost of a pile of tickets forward into position beneath a printing stamp, and at the same time pushes a previously printed ticket out of the machine. The third pair of contacts complete the circuit of an electromagnet which actuates the printing stamp and feeds forward the inking ribbon thereof. The apparatus has been tried on the Posen Electric Street Railway, and has been found to be very satisfactory. The current is taken from the street mains, the pressure being reduced, by means of a resistance, to 200–250 volts. C. K. F.

2311. *Holden Meter.* **A. S. Garfield** and **J. A. Montpellier.** (Ind. Élect. 9. pp. 277–281, July 10, 1900; and Électricien, 20. pp. 81–86, Aug. 11, 1900.)—In this meter there is a wattmeter-system, consisting of a pair of fixed main-circuit coils C, and a pair of high-resistance shunt coils D mounted on a vertical arbor B so as to be capable of turning through an angle limited by stops *d* against the action of springs *b*, F, which also serve for conducting the current to and from the coils D. The arbor B is also provided with an arm *e*, having a pawl which engages with a ratchet-wheel *f* on an independently mounted arbour B^1 so that when the circuit of the shunt-coils D is closed (which is effected once every one or two minutes by a clockwork mechanism), the arbor B will be rotated through a constant angle θ and an impulse given to the arbor B^1, the magnitude of this impulse being proportional to the electric energy in the circuit at that instant. This kinetic energy is taken up by weights *g*, adjustably mounted on arms on the arbor B^1 and is gradually converted into heat in a magnetic brake disc *h* turning between the poles of permanent magnets so that the angle through which the arbor B^1 turns, before it comes to rest, is a measure of the impulse imparted thereto by the arbor E. A retaining pawl is provided for preventing the arbor B^1 from being moved back when the arbor B is returned to its normal position by the springs *b*, F, after the shunt-coil circuit has been interrupted. By connecting the arbor B^1 to a counting train by means of the worm-gear shown, these angular rotations are integrated. The total current taken by the shunt coils of 1,000 of these meters (500 watt) is only from 2 to 3 amperes, and they will indicate accurately at 1 per cent. of the full load. C. K. F.





2312. *Meters for Three-phase Circuits.* **J. A. Möllinger.** (Elektrotechn. Zeitschr. 21. pp. 573–577, July 12; and 597–601, July 19, 1900.)—In the first part of the paper the author deduces various expressions for the power in a three-phase circuit, and considers the arrangements of the wattmeter connections suggested by them. Part 2 deals with the theory of watt-hour meters for three-phase circuits constructed on the Ferraris principle, the various methods of obtaining the necessary phase-relations between the currents in the main and shunt circuits being dealt with in detail. Part 3 contains a detailed description of a three-phase meter constructed on this principle. The moving part is very simple, consisting of two horizontal discs of aluminium mounted on a vertical spindle which carries a worm, geared with the counting mechanism. Each aluminium disc revolves between the poles of a □-shaped shunt electromagnet, and in connection with each disc are two main coils, one on each side of the shunt magnet, with their axes normal to the disc. In the case of a meter intended for 3 × 10 amperes at 120 volts, the power taken by the shunt was about 5 watts, and the constant of the meter was found to vary by not more than 2 per cent. for various conditions of load, ranging from a balanced non-inductive load to an unbalanced inductive one having a power-factor of 0·304. Part 4 of the paper contains a description of a particularly simple form of meter intended for use on a balanced three-phase circuit. The meters are being manufactured by the Elektrizitäts-A.-G. vorm Schuckert and Co., of Nürnberg. A. H.

2313. *Power Supply by Small Motors.* **H. A. Mavor.** (Inst. Elect. Engin., Journ. 29. pp. 889–897; Discussion, pp. 897–899, July, 1900.)—On the basis of direct-current supply at 1d. per unit for power purposes, the author discusses the design of motors between ½ H.P. and 5 H.P., and emphasises the importance of high efficiency. If a ½ H.P. motor, costing £15, works for nine hours per day, the annual cost of energy is about £5, and the interest and depreciation charges, say 30s.; a larger motor of the same output, with 10 per cent. higher efficiency, and costing one-third more at first, would still cost no more per annum than the inferior motor. Small shunt-wound motors are costly, and in the author's opinion series winding is preferable, from both the maker's and the user's point of view. The variation of driving power required by most manufacturing machines between full and no load is very small, and series-wound motors can be designed to meet the conditions with very small variation of speed, and without risk of racing. Starting switches are at present far from satisfactory. The paper is accompanied by curves showing the comparative performances of small series and shunt-wound motors, from which it is seen that the series motors could neither run away, nor be burnt out by a temporary overload.

Discussion.—**W. A. Chamen** dealt with switch gear, and **W. H. Watkinson** referred to the difficulty of speed variation with series motors. A. H. A.

2314. *Switchboard Design.* **H. A. Bertram.** (Elektrotechn. Zeitschr. 21. pp. 667–674, Aug. 9, and 697–699, Aug. 16, 1900.)—This is a detailed description of the author's system of switchboard design. The main switches are actuated at a distance in a room at the back of the board through levers and rods, the switch arm being fitted with curved bars up which an arc can run and so break itself as in the Siemens and Halske lightning arrester. The top contacts of the switch fuses have a similar device. The measuring instruments have their faces flush with the marble panels. Details of interlocking gear, plug fuses, &c., are given, the article being illustrated by thirty figures. E. K. S.

GENERATORS, MOTORS, AND TRANSFORMERS.

2315. *Reluctance of the Teeth in a Slotted Armature.* **W. B. Hird.** (Inst. Elect. Engin., Journ. 29. pp. 933–941, July, 1900.)—In predetermining the characteristic of a dynamo with slotted armature, the calculation of the ampere turns required to pass a given number of lines through the teeth is difficult. The usual approximate methods err on the safe side by giving too high a value for the ampere turns. The author gives an approximate solution and curves that have been used in practice with satisfactory results. He also indicates a more accurate method of solving the problem, and mentions that an instrument has been contrived to simplify the calculations. He says that the reluctance of the teeth is of importance in calculating the effect of the cross-magnetising turns. The total flux entering a smooth core armature is not affected by the cross turns under the armature pole. When, however, there is iron in the gap, as, for example, the teeth of a slotted armature, then he proves mathematically that the total flux is not independent of the cross turns. The variation of the flux is appreciable when the teeth are worked at high inductions, and special allowance must be made for it in the case of large machines. A. R.

2316. 800-*kw Steam Alternator by the Compagnie de Fives-Lille at the Paris Exhibition.* **J. Reyval.** (Écl. Électr. 24. pp. 241–247, Aug. 18, 1900.)—A very full description of a three-phase alternator coupled to a compound horizontal engine, the output being 800 kw. (with a power factor of 0·7) at 2,200 volts, the current per phase being 210 amperes with a frequency of 50 periods.

Engine.

High pressure cylinder	700 mm. dia.
Low pressure cylinder	1,300 ,,
Stroke	1,400 ,,
Variation in one revolution	$\frac{1}{150}$
Steam pressure	10 kg. per sq. cm.

Alternator.

Diameter of armature core	6 m.
Length of armature core	70 cm.
Diameter of wire	3·9 mm.
Total resistance of each armature winding	0·0778 ohms.
Loss in armature winding	1·3 per cent.
Weight of armature ring complete	33,500 kg.
Number of poles	76.
Air-gap	7 mm.
Number of turns on each pole	155.
Diameter of wire	4·7 mm.
Total resistance	3·06 ohms.
Weight of field-magnet system with flywheel	35,000 kg.

The article is illustrated by ten figures and a sheet of curves. E. K. S.

2317. *Standardisation in Specifying the Performance of Generators.* **G. Dettmar.** (Elektrotechn. Zeitschr. 21. pp. 727–733, Aug. 30, 1900. Paper read before the 8th Jahresversammlung des Verbandes Deutscher Elektrotechniker in Kiel.)—The author draws attention to the difficulties which frequently arise in the case of disputes on account of the absence of definite standards with respect to the performance of generators. Inquiries addressed to manufacturers show that the need of setting up definite standards is widely felt. Dealing with the question of output, the author points out that in the case of motors intended for cranes, railways, rolls, &c., and in fact wherever the power is liable to great fluctuations, the term "output" should be more precisely defined. Another uncertainty in connection with this term arises with respect to the time during which the machine is supposed to give its rated output; in some cases five hours is assumed to be a sufficient test, in others six, eight, ten, or more. The author next considers the question of heating, and emphasises the importance of specifying the method by which the rise of temperature is to be determined. The difference between the thermometer and the increase of resistance methods may amount to as much as 40 per cent. for armatures, and 60 per cent. for field magnets. He gives an account of some experiments carried out with a view to testing the highest permissible temperature for cotton-covered wires, and arrives at the conclusion that for moving coils the maximum should never exceed 90° C., the cotton becoming brown and brittle if heated beyond this limit; for fixed coils a slightly higher maximum might be allowed. From this the author concludes that the highest rise of surface temperature as measured by a thermometer should be fixed at from 32° to 42° C. for rotating coils, and at from 35° to 45° for stationary coils. The concluding section of the paper deals with the methods of determining the efficiency and analysing the losses in a generator. In specifying the efficiency regard must be had to the material of the brushes, a difference of standard being introduced on account of the much higher loss which occurs with carbon brushes. A. H.

2318. *Farcot Two-phase Steam Alternator at the Paris Exhibition.* **C. F. Guilbert.** (Écl. Électr. 24. pp. 41–49, July 14, 1900; also Ind. Élect. 9. pp. 273–277, July 10, 1900.)—Description of a two-phase generator set at the Paris Exhibition. Both the alternator and the horizontal engine which drives it were built at the Farcot Works at Saint Ouen. The engine is remarkable in that, although working with high-pressure steam at $\frac{3}{10}$ cut off and 78½ revs., it indicates 1,600 H.P. with only one cylinder [see Abstract No. 2302, 1900)].

The alternator is of the inductor type, and is specially fitted with Hutin and Leblanc "amortisseurs"; it is said that these, together with the heavy mass of the inductor wheel, give a sufficiently even turning moment for running in parallel. The alternator gives 880 kw., with a power factor of 0·85, the frequency being 42 cycles per second, which requires 64 poles (32 on each inductor ring).

The armature conductors are 3·5 mm. × 38 mm., or 133 sq. mm. area, and the resistance of each half is 0·113 ohm when warm. The external diameter of the armature is 6·8 metres, and the internal diameter 5·515 metres, the weight being 60,000 kg. The outside diameter of the inductor wheel is 5·5 metres, its weight being 50,000 kg. The single exciting coil consists of 460 turns of copper wire, 7·5 mm. diameter, having a resistance of 3½ ohms.

The "amortisseur" coils are formed of copper 28 mm. in diameter, there being five conductors opposite each alternate slot in the armature core.

The exciter is direct driven, has six poles, and gives 60 amps. at 220 volts; diameter of armature 750 mm., and length 450 mm.

The article is an important one, and includes five good illustrations.

E. K. S.

2319. *Dynamos and Motors.* **F. Niethammer.** (Elektrotechn. Zeitschr. 21. pp. 528–531, June 28; and 549–551, July 5, 1900.)—This paper contains notes on the following subjects: (1) The theory of rotary converters, more especially in connection with their heating and armature reaction; (2) Armature reaction in dynamos and alternators; (3) The determination of the drop in polyphase generators when magnetic leakage is taken into account; (4) The losses in the pole-pieces of dynamos; (5) Sparking in dynamos with toothed-core armatures, some formulæ being given which are intended to serve as criteria regarding the quality of the machine from the sparking point of view; (6) Calculation of the inductance of an armature coil from the shape of the slots in which it is embedded; (7) Predetermination of maximum rise of temperature of field and armature coils. In connection with this latter subject the author gives the following formula, which is said to be equally applicable to stationary coils, armatures, and commutators:—

$$t = \frac{w}{S(1 + 0{\cdot}3\sqrt{v})} C(1 + 0{\cdot}2d),$$

where t = rise of temperature, in degrees C.; w = watts dissipated; S = area of radiating surface, in sq. cms.; v = peripheral velocity, in metres per sec.; d = depth of winding, in cms. C is a constant whose value lies between 250 and 350. For armatures d may be put = 0, and for commutators, in addition to putting $d = 0$, $\frac{C}{2}$ must be used instead of C. Similarly, in the case of the rotors of induction motors, on account of the practical absence of hysteresis and eddy-current losses in the core, $\frac{C}{2}$ must be used instead of C. In applying this formula, end surfaces and inner surfaces must only be credited with ½ to ¼ of their actual values. A. H.

2320. *Induction Motors with Large Starting Torque.* **M. Déri.** (Ind. Élect. 9. pp. 324–327, Aug. 10, 1900.)—The principle on which the construction of such motors depends has already been noticed in a previous Abstract [see Abstract No. 1285 (1898)]. The present paper contains an illustrated description of a motor of this type exhibited in the Austrian section of the Paris Exhibition. It is stated that a starting torque equal to 2·6 times the normal running torque may be obtained with a current not exceeding 1·6 times the normal current taken by the motor. A. H.

2321. *Induction Motor Diagrams.* **R. Goldschmidt.** (Elektrotechn. Zeitschr. 21. pp. 693–697, Aug. 16, 1900.)—The total power given to the rotor of an induction motor may be supposed to be dissipated in an imaginary equivalent resistance $r'_2 = r_2/\sigma$, where r_2 = resistance of rotor, and σ = slip. The power transformed into mechanical power will then correspond to that dissipated in a resistance $r_2\left(\frac{1}{\sigma} - 1\right)$. The induction motor may now be replaced by a transformer whose secondary contains a resistance r_2/σ; and this has the same effect on the primary as a resistance of amount $\frac{r_2}{\sigma} . a^2$, where $a = \frac{\text{primary turns}}{\text{secondary turns}}$, placed in the primary. If further, L_1 = leakage inductance of primary, L_2 = leakage inductance of secondary, r_1 = resistance of primary, $L = L_1 + a^2L_2$, $r = r_1 + a^2r_2$, then the transformer may be replaced by a simple inductance coil of resistance $r + a^2r_2\left(\frac{1}{\sigma} - 1\right)$, and inductance L.

In order to take into account the magnetising current, we may suppose an auxiliary inductance coil of resistance r_0 and inductance L_0 joined in parallel with the main inductance coil[1] (fig. 1). Making use of the transformation just explained, the author establishes the following method of studying the behaviour of an induction motor. The short-circuited rotor standing still, the P.D., V, the current *i*, and power *w* are measured (in most cases it will be necessary to carry out this measurement at a P.D. below the normal, and assume that *i* is proportional to the P.D.). Further, the current i_0 and power w_0 are measured when the motor is running light. The data so obtained are used for constructing the diagram shown in fig. 2 as follows: Draw a right-angled triangle, ADC, in which $AC = i$, and $CD = \frac{w}{V\sqrt{3}} =$ the power-component of *i*. Lay off $DF = \frac{3i_1^2r_1}{V\sqrt{3}}$, where $i_1 = i - \frac{i_0}{2}$, and join FA. From C draw CE at right angles to AC, and on AE describe a semicircle. From A

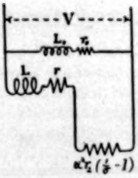


FIG. 1

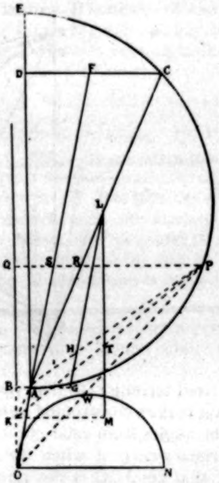


FIG. 2.

draw $AO = i_0$ in such a direction as to make AB (where AB is perpendicular to AE) $= \frac{w_0}{V\sqrt{3}}$. Draw $ON = 1$ at right angles to OB, and on ON describe a semicircle. From any convenient point L in AC draw LG parallel to FA. Next produce CA until it intersects BO in K, and construct the right-angled triangle KLM. If we take any point P on the large semicircle, then $OP =$ primary current; $OW =$ power factor; $PQ =$ total power absorbed by motor; $PS =$ total power given to rotor (to a suitable scale PS will also represent the torque); $GH = \sigma =$ slip, if GL be taken to represent a slip of 100 per cent., and $LT =$ equals electrical efficiency of motor, if LM be taken as 100 per cent. By completing the circle on AE the diagram may be extended to the case of an induction generator. In the second part of the paper the author applies a similar method to the study of a single-phase motor. A. H.

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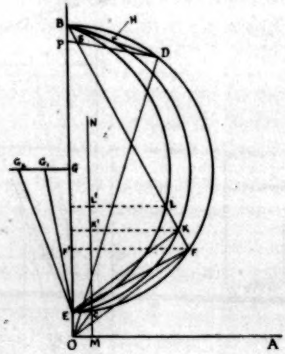
[1] This would make the magnetising current constant, which is known not to be the case. But, as the author points out, the necessary correction may be applied after the value of the main current has been determined.

2322. *Testing Induction Motors.* **Heyland.** (Écl. Électr. 24. pp. 17–26, July 7; and 49–59, July 14, 1900.)—The introductory portion of the paper is devoted to a general account of the theory of induction motors; this is followed by a description of the author's diagram (explained below) for such motors. By means of such a diagram the behaviour of any given motor may be completely predetermined. The use of the diagram is exemplified by a number of actual tests carried out on various types of motors. In order to obtain the data necessary for constructing the diagram, the following measurements are required: (1) The current and power taken by the motor when running light; (2) The short-circuit current and power when the rotor is prevented from turning; (3) The resistance per phase of the stator winding. The diagram is then constructed as follows: Take two lines, OA and OB (see fig.), at right angles from each other. From O lay off a vector OC to represent the primary current when the motor is running light, the angle AOC being such that cos AOC is the power-factor. Next lay off a vector OD to represent the primary short-circuit current (rotor at rest), cos AOD being the corresponding power-factor. Through the points C and D draw a circle having its centre G on the line OB. Then the extremity of the primary current vector travels along this circle as the load is varied. Let OB be taken to represent the P.D. of the supply mains. Then BD will represent, to the same scale, the total resistance drop on short-circuit. Let r_p be the resistance of the stator windings per phase, and i_s the short-circuit current. From D lay off DH $= \sqrt{3} \times r_p i_s$, and draw a circle through the points B, H, E, having its centre at G_1. Draw a third circle passing through B and E, and touching BD at B; let G_2 be the centre of this circle. Next from D draw DP, making the angle DPB equal to the angle in the segment EKB of the circle which has its centre at G_1. Lastly, through C draw a line MN parallel to OB. The diagram may now be used as follows for the purpose of studying the behaviour of the motor under varying conditions of load: Take any value of the primary current, say OF. Then cos AOF gives the corresponding power-



factor. Join BF, and from F, K, and L draw perpendiculars to OB. Then FF′ represents the total power supplied to the motor (to the same scale as that to which OM represents the power taken when running light); KK′ represents the useful torque; and LL′ the brake-power; all corresponding to the current OF. Further, PS gives the percentage slip (PD corresponding to a slip of 100 per cent.). The overload capacity of the motor, its starting torque, &c., are easily determined by means of the diagram. The concluding portion of the paper deals with single-phase motors, the action of such motors being briefly discussed. The author points out that single-phase motors require careful designing, and that it would be a great mistake to suppose that a good polyphase motor would also make a good single-phase one if allowed to run on one phase only. A. H.

REFERENCES.

2323. *Design of Induction Motors.* **J. Fischer-Hinnen.** (Zeitschr. Elektrotechn., Wien, 18. pp. 346–348, July 15; 357–364, July 22; 370–375, July 29; 381–388, Aug. 5; and 397–403, Aug. 12, 1900.)—A series of articles relating to the design of induction motors, and consisting mainly of a useful collection of tables and formulæ. A. H.

2324. *Distribution of Induction over Pole-face in Dynamos.* **C. Westphal.** (Elektrotechn. Zeitschr. 21. pp. 747–749, Sept. 6, 1900.)—By considering the magnetomotive forces and reluctances of the various parts of the magnetic circuit, the author constructs curves, similar to those given in Abstract No. 1744 (1900), giving the field distribution around the armature circumference (1) when the machine is running light; (2) when it is loaded, the brushes not having any lead; and (3) the brushes having a lead. The results obtained are applied to find (*a*) the drop of potential at full load when the excitation is kept constant; (*b*) the increase of excitation required to maintain the P.D. constant at full load. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2325. *Aluminium Wires and Polyphase Transmission.* **F. A. C. Perrine** and **F. G. Baum.** (Amer. Inst. Elect. Engin., Trans. 17. pp. 391–423, June and July, 1900.)—In some results previously published by one of the writers there were several misprints [see Abstract No. 318 (1900)]; these are now corrected in this paper. Full details are given of the 43-mile power transmission line of the Standard Electric Company of California. A temporary two-phase arrangement is employed so as to utilise the present machinery of the Company, but the conversion to three-phase will take place shortly. Each pole has three cross arms whose ends form a hexagon. The insulators are of glass, of the flat-topped triple petticoat type, and are supported on long eucalyptus pins. An aluminium strand ¾ inch in diameter will be used, and the total weight of aluminium will be nearly 450 tons. A. E. Kennelly reports as follows on the aluminium wire at present in use:—

Diameter	293·9 mils.
Weight per mile	419·4 lbs.
Resistance per mil. foot at 25° C.	17·6 ohms.
Resistance per mile at 25° C.	1·0077 ohms.
Conductivity compared with copper	59·9 per cent. by dimension.
Tensile strength of wire	1,549 lbs.
No. of twists in 6 inches for fracture	17·9.
Tensile strength per square inch	32,898.

He compares it with copper as follows:—

Diameter for the same conductivity	1·27	times copper.
Area " " "	1·64	" "
Tensile strength " "	0·629	" "
Weight " "	0·501	" "

In erecting aluminium lines it has to be remembered that it is easy to permanently stretch the wires and that they have a large temperature coefficient. The results of experiments made by the Pittsburg Reduction Company and the authors on the sag of spans of aluminium wire at various temperatures and tensions are given in tabular form. The instructions to the line foreman as to the methods of jointing, spiralling the wires, &c., are also published. The breaks of the wires on the Seattle line are stated to have been due to contraction in the cold weather, insufficient sag having been allowed.

The writers also give experimental data and mathematical calculations of the capacity, self and mutual inductance, ohmic resistance and insulation resistance of transmission lines. In addition to the line mentioned above they experimented on an aluminium line 62 miles in length. They prove that the line capacity of an overhead three-phase system of wires may be considered as that of three condensers connected between the wires in a star and not a mesh pattern. If the capacity be considered as mesh connected, then the charging current in each wire would be $\sqrt{3}$ times the charging current of a single-phase line; but if it were star connected then the charging current would only be $\frac{2}{\sqrt{3}}$ times that of a single-phase line. By experiment they found the latter to be the correct supposition.

Valuable formulæ are proved by original methods for the capacity of line wires. If the centres of the wires are at the corners of an equilateral triangle whose side is d, and if r be the radius of the wires whose length is L miles, then we can calculate the charging current by supposing three condensers each of capacity K where—

$$K = \frac{0\cdot0388L}{\log_{10}\frac{d}{r}} \text{ microfarads}$$

connected starwise between the three mains. The radius of the wires is supposed to be small compared to their distance apart. The influence of the earth on the capacity can in general be neglected. The self-inductance of one wire of the three wires being S, then in calculating the inductive drop in a loop we can assume that the self-inductance of the two wires is $S\sqrt{3}$ where—

$$S\sqrt{3} = 0\cdot000558\,[2\cdot303 \log \frac{d}{r} + 0\cdot25]\, L, \text{ henries.}$$

The effect of the charging current on the regulation of the system is discussed mathematically, and it is stated that the method given yields results as accurate as could be obtained by actual measurements with the best instruments.

The paper concludes by describing some transmission line troubles. At the receiving end of the two-phase forty-mile line there are in operation two shunt-wound synchronous motors of 50 and 100 kw. respectively. Their working at first was very unsatisfactory. At no-load the current they took was nearly equal to that at full-load, and they were very unstable, easily falling out of synchronism. This was not due to "hunting," as copper bridges put between the poles of one of the motors did not improve its running. The large no-load current was thought to be due to the difference in wave shape between generator and motor E.M.F.'s. By neutralising the capacity current by means of inductive coils the 50 kw. motor at no-load only took 3 amperes per phase instead of 13, and the variation in volts at the receiving station at different loads was reduced from 10 per cent. to 3 per cent., and nearly all this 3 per cent. was traced to the change in speed of the water-wheels.

A. R.

2326. *Distribution of Electricity.* **G. Wilkinson.** (Elect. Engin. 26. pp. 47–50; Discussion, p. 50, July 13, 1900. Paper read before the Municipal Electrical Association, June 22.)—The author emphasises the importance of reliability in the distributing system, and discusses the various methods of distribution in use, with the purposes for which they are suitable. Service boxes for three-core cables cost only half as much as for triple concentric cables, while the frequent cuttings necessary with the latter impair the conductance of the mains. Paper-insulated concentric mains with the outer earthed are the best for high pressures. Too many types of joint-box are in use. A disconnecting-box should be fixed at every street corner; but fuses should not be used. In mechanical joints the outers of concentric cables are best clamped between two flat metal discs, made in halves; the boxes ought also to be in halves, to avoid the necessity of cutting the cable. The connections should be enclosed in a light box, to keep the waterproof compound off them. A good high-tension joint-box is that in which the ends of the cables are brought in vertically through the bottom; in this case the "inner" connecting-bar may be made to serve as a switch if required. These boxes cost less than £5 5s. each complete, with outer box and labour, whilst the ordinary forms cost at least £7 7s. 6d.

Discussion.—**C. H. Wordingham** said that in Manchester bare copper mains were used for outlying districts where possible. **W. A. Chamen** preferred earthenware troughing for the solid system. A. H. A.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2327. *Chicago Generating Stations.* (Elect. World and Engineer, 35. pp. 729-741, May 19, 1900.)—The stations worked by companies supply 17,600 arc lamps and 512,000 incandescent lamps, while 870 isolated plants supply 13,800 arcs and 372,000 incandescents; the municipality also owns four stations running 3,500 arcs for street lighting.

The Edison Company feeds current into its 230-volt network at six stations, which are connected by three-phase, 25-cycle, 4,500-volt mains, double-current generators and rotary converters being employed. It is intended to concentrate the generating plant mainly in two or three of the stations most conveniently situated as regards coal and water supply, and to use the others as converting substations, the steam plant in the latter being used as a reserve for times of heavy load. Double-current generators have proved very advantageous, and a 2,500 kw. machine of this type is to be added at the chief station.

One storage-battery substation has a capacity of 22,400 amperes for one hour, or 44,800 ampere-hours at an eight-hour rate of discharge. Boosters are preferably driven by synchronous motors wound for 4,500 volts. Many commercial arcs are being changed over from series circuit to the low-pressure constant potential mains. The rotary converters have from 4 to 10 poles; while the double-current dynamos have 20 or more, with the same number of sets of brushes. Some of the latter machines have face commutators.

The Commonwealth Company is constructing a model polyphase station to supply all loads within a district of 63 square miles, comprising the southern part of the town. The three-phase, 60-cycle generators will give 2,300 volts between the junction of the Y and each outer terminal. A fourth wire will be brought from the junction, and each of the 2,300 volt single-phase feeders will be connected between this fourth wire and one of the outer terminals, the feeders being divided in such a way as to balance the load. Each feeder can be independently regulated, and can be switched on to any of the three phases. Three-phase feeders are to be run for motors. The two-wire lighting feeders run to transformers converting down to 2 × 115-volt three-wire distributors.

The three-phase feeders supply transformers with Y-connected primaries and delta-connected secondaries, giving 230 volts between mains. All instruments on the switchboard will be of the horizontal edgewise type, and they will be supplied from instrument transformers with earthed secondary. Thus no high pressures will be taken to the operating-board, which comprises the upper part of the switchboard and is reached by a gallery. The lower part of the switchboard consists of the 'bus-bar panels carrying those switches and other apparatus which do not require frequent handling. The 'bus-bars will be treated with fireproof paint, and mounted on glass insulators. All cables about the board are paper-insulated and lead-covered.

The generators will be General Electric revolving field machines mounted between the cranks of Southwark vertical cross-compound engines, with which jet condensers will be used. The Babcock and Wilcox 500-H.P. boilers have superheating coils, placed so as to intercept the hot gases after their first crossing of the water-tubes. There is one generating unit of 400 kw., the others being 1,000 kw. each. The ultimate possible capacity of the station, of which sectional drawings are given, is 10,000 H.P.

The municipal plants are four in number and consist mostly of vertical marine-type cross-compound condensing engines of 500 H.P. to 800 H.P. connected through clutch couplings to line shafts, to which are belted Western Electric and Brush series arc dynamos of 100- to 160-light sizes. There are 270 miles of streets lighted by electricity, 713 by gas, and 327 by gasolene. The corresponding costs of lighting per mile are $567, $785, and $442. The cost per lamp (without any interest charges, however) is $55·9 per year, or $0·0138 per hour. W. H. E.

2328. *New York Electricity Works.* (Elect. World and Engineer, 35. pp. 931–934, June 23, 1900.)—System: Two-phase alternating current transformed at substations from 3,000 to 105 volts. The boiler-room contains twelve 600-H.P. boilers of the upright water-tube type, generating at 150 lbs. per square inch. Each boiler contains 588 tubes 11 feet long and 3 inches diameter. The feed-water is heated by two heaters using exhaust steam, which raise the temperature to about 200°. Coal is dumped into a filler below the street level, and is carried to the bunkers by an endless chain of buckets. From the hoppers in the bottom of the bunker it is shot to the different boilers. The engine-room contains eight "Columbian steepled compound" engines by the Westinghouse Machine Company of 1,200 H.P. each at 200 r.p.m. The cylinders are in tandem and measure 21½ inches and 37 inches, with stroke of 22 inches. Three 100-H.P. Westinghouse single-action tandem compound engines drive the exciters. Close to each engine is a combined separator and receiver containing eighteen times the volume of steam required for one stroke; these maintain a uniform flow of steam in the pipes. Below the engine-room are two Worthington jet condensers of 5,000 H.P. each. Each large engine drives directly a 750 kw. two-phase, 3,000 volt Westinghouse generator. The armature is mounted on the engine shaft, the generator having but one bearing. Each small engine drives through a flexible coupling a 75 kw. Westinghouse exciter. Sixteen feeders supply transformers usually placed under the pavement. The main switches are of the Westinghouse high-tension plunger type; in these each circuit is broken at two points and each break takes place in a small enclosed air chamber formed by a porcelain tube. A small vent produces a lateral draught which tends to extinguish the arc. In the old station three new Westinghouse generators of 400 kw. each are run by three old Corliss engines in parallel with the new station, but these will shortly be replaced by four Westinghouse-Parsons steam turbines of 2,500 H.P. each, connected directly to generators of 1,500 kw. each running at 1,200 r.p.m. At present current is supplied for about 400,000 8-c.p. lamps, 2,000 arc lamps, and 3,000 H.P. of Westinghouse induction motors. G. H. B.

2329. *Gloucester Electricity Works.* (Elect. Engin. 26 pp. 78–85, July 20, 1900.)—System: Continuous current, three-wire, with batteries. The boiler-room contains three Lancashire boilers, 30 feet by 8 feet, of steel plate $\frac{11}{16}$ inch thick, by Yates & Thom ; working pressure 160 lbs. There is on order to Tinkers Limited, one Lancashire boiler, 30 feet by 8 ft. 6 in., capable of evaporating 8,000 lbs. of water per hour, with plates $\frac{7}{8}$ inch thick, and to Heenan & Froude, a twin-cell refuse-destructor having a capacity of fifty tons per twenty-four hours. Above the cells will be the combustion chamber, and above this a water-tube boiler having 1,300 feet of heating surface. The feed-water is heated by a feed-heater and a Green's economiser of ninety-six tubes. Coal is fired by Proctor's mechanical stokers, driven by a 5 kw. motor. The engine-room contains two engines ; the larger is a triple-expansion engine with one high and two intermediate cylinders placed above three low-pressure cylinders, giving 500 I.H.P. at 350 r.p.m. ; the smaller is a two-crank compound engine with two cylinders, giving 250 I.H.P. at 380 r.p.m. Two jet condensers by the Blake and Knowles Steam Pump Company can each condense 10,000 lbs. of steam per hour at a vacuum of 26 inches. There is on order a Willans central-valve triple-expansion engine of 500 I.H.P. at 320 r.p.m. The larger engine drives directly two Silvertown dynamos of an aggregate output of 300 kw. at 440–500 volts. They have drum-bar armatures and shunt-wound magnets. The smaller engine drives directly two similar dynamos of 75 kw. each at 220–250 volts. There are on order two Mather & Platt dynamos, giving each 680 amperes at 220–250 volts at 320 r.p.m. A 15 kw. booster takes current at 220–250 volts, and supplies 100 amperes at 20–150 volts at 780 r.p.m. Five feeders of 0·4 square inch section and one of 0·25 square inches supply the private lighting ; they consist of triple concentric lead-sheathed cables, laid by the Callender Company in cast-iron troughs, which are filled with bitumen. Their total length is 3¾ miles. The public arc lamps are supplied by one $\frac{7}{16}$ single lead-sheathed cable laid direct in the ground. A three-core $\frac{7}{20}$ pilot cable runs with each feeder. The distributors are similar to the feeders and have a total length of 12⅓ miles. The switchboard is by Crompton & Co. The middle wire is connected to earth through a recording ammeter and automatic switch which falls at 10 amperes and puts a resistance in circuit. The station is equipped with two batteries of E.P.S. accumulators, type K.W.S., each battery contains 140 cells and has a discharge capacity of 210 amperes for two hours, 168 for 3½ hours, 112 for seven hours, or 80 for ten hours. There are thirty plates in a cell, contained in a lead-lined wood box. The price charged is 7d. and 2d. per unit for lighting and 4½d. and 1½d. per unit for power, the higher rate being charged for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand. G. H. B.

2330. *Destructor and Electric Power Station at St. Helens.* **J. S. Highfield.** (Elect. Rev. 47. p. 7, July 6, 1900.)—The installation includes two destructor furnaces, each having two cells on the Beaman and Deas principle, with closed ashpits, forced draught being supplied underneath the hearths from a centrifugal blower driven by an electric motor, a Babcock-Wilcox boiler having 1,740 square feet of heating surface with a superheater, and a Green's economiser having ninety-six tubes. The gases from each furnace reach the boiler through a combustion chamber and afterwards pass through the economiser. The steam, with about 100° F. of superheat, passes to four Willans & Robinson three-crank compound condensing engines with direct coupled generators of a total capacity of 600 kw. A Wheeler condenser and a Klein cooling tower form the condensing plant. The results obtained in ordinary work, day by day in May last, are as follows :—

	Tons.	Cwts.
Average weight of refuse burnt per week	148	18
„ „ clinker and ash per week	40	8
„ „ mortar made...............................	15	2
„ „ refuse per shift of nine hours	18	1½

Average units used to work fan per ton, 9.
„ generated from steam per week, 7,062.
„ „ per ton burnt, 50.
Average wages per ton burnt, 1s. 1¾d.

[See also Abstract No. 1797 (1899).] F. J. R.

2331. *Automatic Coal-handling Plant at the Leeds Electric Power Station.* (Mech. Eng. 6. pp. 44–46, July 14, 1900.)—The distribution of coal to large batteries of boilers without manual labour is an important matter, and the appliances introduced to this end in America are being adopted in this country. This article describes with illustrations the arrangements for handling by machinery all the coal required by eight Lancashire boilers, 30 feet long by 8 ft. 6 in. diameter, and one Babcock-Wilcox boiler, placed in two groups, separated by the space required by an economiser and a chimney—the boiler-house being about 177 feet long by 62 feet wide, with the coal stores opposite the boiler fronts, but not quite parallel with the boiler-house proper. For details the article must be consulted. F. J. R.

2332. *Swansea Electric Tramways.* (Electrician, 45. pp. 433–436, July 13, 1900.)—This system has been equipped by the British Electric Traction Company. The route at present served is about 5½ miles. The generating station is at St. Helens, which is at one end of the system, but will be about central when the company has converted the Mumbles Railway, which is at present worked by steam. The boiler-house contains two Babcock-Wilcox boilers, each capable of evaporating 7,000 lbs. of water per hour at 150 lbs. steam pressure from a feed temperature of 150° F. A superheater adds 100° of superheat. The condenser is of the Wheeler horizontal surface type of 700 square feet area. The engine-room contains at present two large sets consisting of Ball & Wood engines, having cylinders 15½ inches and 31 inches diameter, and 16-inch stroke, of 350 I.H.P., coupled to Westinghouse 8-pole dynamos, over-compounded to compensate for feeder-drop and capable of meeting a load of 365 amperes at 550 volts. There is also a smaller 50-H.P. Alley-Maclellan engine coupled to a motor-generator and the usual negative boosters, giving 4¾ kw. at 950 r.p.m. There are forty-one cars in all equipped with the usual 25-H.P. motors, &c. E. K. S.

2333. *Glasgow Electric Tramways.* (Tram. Rly. World, 19. pp. 343–356, August, 1900.)—The station is divided into three sections—boiler-room, 244 ft. × 84 ft. × 70. ft. high ; engine-room, 244 ft. × 75 ft. × 64 ft. high ; and auxiliary plant-room, 244 ft. × 40 ft. × 52 ft. high. The two chimney-stacks are 263 ft. high and 16 ft. internal diameter. The boiler-room contains sixteen Babcock & Wilcox boilers in eight batteries of two each, working at a pressure of 160 lbs., each boiler being capable of producing 20,000 lbs. of steam per hour. The feed-water is heated by means of two economisers supplied by the Clay Cross Company, each capable of heating 12,000 gallons of water per hour from 90° to 160° F. Coal is stored over the boilers in bunkers holding 2,400 tons, and is fired by Babcock & Wilcox type of mechanical stoker, driven through shafting by two 30-H.P. motors. The mechanical bucket-conveyer can handle fifty tons per hour at 45 ft. per minute. The engine-room contains four engines, each coupled direct to a three-phase generator, the maximum power being about 5,000 I.H.P. at a speed of 75 r.p.m. They are of the vertical compound three-cylinder condensing type, and fitted with special Corliss valve gear. Two of these are by the Allis Company, and the remaining two by Musgrave & Sons. In the Allis engine the high-pressure cylinder is 42 in. diameter, and each of the low-pressure cylinders 62 in. diameter, with a stroke of 5 ft. The engine weighs 700 tons, of which the flywheel, 24 ft. in diameter, accounts for 98 tons. The governors are such that the speed is not to vary more than 1½ per cent. above or below the normal speed under any fluctuations from no load to maximum. The angular velocity is not to vary more than ⅕ per cent. during any revolution at any constant load. In addition to the automatic control governor there is also an emergency governor designed to cut off the entire supply of steam should the speed of the engine increase by more than 5 per cent. above the normal. The guaranteed steam consumption is 14 lbs. per B.H.P. hour. The generators are supplied by the British Thomson-Houston Company, and have an output of 2,500 kw. at 6,500 volts and 25 periods. The weight of each generator is 90 tons, of which the revolving field-magnet system accounts for 38 tons. The guaranteed efficiency is 96, 95, and 93½ at full, three-quarter, and half load respectively. The exciters are 6-pole 50 kw., giving 100 volts, and driven by Allen high-speed engines. The feeders are three-core cables, their area in some cases being 0·15 and in others 0·1 sq. in. They are paper-insulated, with a lead covering of $\frac{3}{16}$ in. thickness, and are carried through the wall of the power-house into a tunnel, and from thence to each of the five substations. The substations contain 200 kw. static Westinghouse oil-cooled transformers, stepping down from 6,500 to 310, 330, or 350 volts, according to the points at which the coils may be tapped. The efficiency is 97½ and 97 per cent. at full and half load. Three of these transformers supply each of the 500 kw. rotary converters, over-compounded from 500 to 550 volts. They are 6-pole machines, running at 500 r.p.m., and were supplied by the Westinghouse Company. The efficiencies at full, three-quarter, and half load are 95, 94, and 92½ per cent. respectively. Each rotary has a three-phase motor connected at one end of the shaft for the purpose of starting and bringing the rotary into synchronism. At the opposite end of the shaft is a continuous current booster, designed for dealing with part of the return current from the tramway tracks so as to minimise and control the drop in the rails. All the cables, high and low tension, were supplied by the National Conduit and Cable Company of New York, and it may be mentioned that there is in all approximately 3,000,000 ft. of pipe in the cableways. The contractors for the permanent way laid about one-third of the ducts, consisting of earthenware pipes, the National Company laying the remainder, consisting of their cement-lined tubes. The track is equipped on the overhead system, the trolley wires being supported by span wire fixed to the walls of buildings where possible, and otherwise from post to post across the street. The trolley wire is of hard-drawn copper, No. 00 B. & S., 0·365 in. diameter. The rails are of the steel grooved girder type, weighing 98 lbs. per yard, with groove 1¼ in. by 1¼ in. so as to take the flanges of ordinary railway waggons, the gauge being 4 ft. 7¾ in. The rails are in lengths of 60 ft. each. The fishplates are 31 in. long and weigh 74 lbs. per pair, and the joints are bonded with two long No. 0000 B. & S. solid copper bonds with Daniell terminals through the web; there are also two similar bonds through the base of each rail, which is laid on a 6-in. bed of concrete. The cars are carried on Brill single trucks, equipped with two motors with series parallel controllers. Most of the cars are being built by the Corporation themselves. *Drawings:* The article is illustrated by seventeen line drawings and a route map of the district served.

E. K. S.

2334. *Southport Lighting and Traction System.* (Electrician, 45. pp. 510–512, July 27, and 546–550, Aug. 3, 1900.)—System: For lighting, single-phase alternating current at 2,000 volts with substations transforming to 100 and 200 volts, the latter for outlying districts; for arc-lighting, Ferranti rectifiers. For traction, continuous current at 500–550 volts. The boiler-room contains six Lancashire boilers, each 28 feet by 7 feet; grate area, 66 square feet. During tests, with a mean pressure 132 lbs. per square inch, full-load consumption was 15 lbs. of steam and 1·8 lbs. of coal per I.H.P. hour; at three-quarters load and half load corresponding figures were 15·3 and 1·86 lbs., and 16 and 1·97 lbs. Musgrave & Co. are putting in three Lancashire boilers, 30 ft. by 8 ft. 6 in., rated at 600 H.P. in aggregate, with superheaters for 120°. The feed-water is heated by one Roberts economiser of 288 tubes; one of 360 tubes is to be added. Coal is stored in bunkers above the boiler-room floor, and is fired by hand. The engine-room contains, for lighting, two cross-compound Corliss condensing engines of 250 I.H.P. each, erected in 1895 and 1896; one 500 I.H.P., erected in 1897; and one vertical three-crank tandem-compound engine of 600 kw., with piston gear, running at 214 r.p.m. —all by Musgrave & Co. The particulars of the 1897 engine are: Cylinder diameters, $17\frac{1}{32}$ and $33\frac{1}{64}$ inch, not jacketed; stroke, 3 ft. 6 in. During full-load test the speed was 96 revs., mean piston speed 672 feet, mean I.H.P. 490·3, mean vacuum in condenser 27 inches. The 600 kw. engine has three separate jet condensers. For traction there is one Belliss E.C. No. 12, 375 B.H.P. engine, working at 130 lbs. with 100° of superheat, running at 350 revs. Guaranteed steam consumption 28 lbs. per kw. hour. For lighting, the 1895, 1896, and 1897 engines drive directly three Ferranti alternators of the revolving field type, with armatures connected in series and lap-wound. The 600 kw. engine drives directly a Ferranti alternator of the revolving armature type, the armature being connected in two parallel halves. It gives 286 amperes at 2,100 volts, running at 214 r.p.m. Frequency 50 revs. Two Cowan's boosters will raise the pressure by 150 volts at 100 amperes. Two Ferranti rectifiers are each capable of supplying forty-two 15-ampere arcs. The Parker exciters are driven by rope gearing off shafts. For traction, the engine drives directly one 200 kw. compound-wound Peebles dynamo, 4 pole, with drum armature. Pressure, 500–550 volts; efficiency, 89 per cent. at full load. A second set is about to be laid down. Feeders: For lighting, no details of feeders are given. For traction, one feeder of 0·4 square inch section (three more are to be laid) and two insulated rail feeders of 0·75 square inch section for the centre of the system are laid. The feeders are laid on the Callender solid system in U-shaped stoneware troughs, filled with compound and covered with a stoneware brick. At the feeding-points vulcanised indiarubber wire is employed from the section boxes to the trolley line. The track is equipped on the overhead trolley system; steel tubular poles carry, by means of brackets, two trolley wires on insulators held by a short span wire below the bracket arm. The two trolley wires are of 00 B. & S. gauge (0·364 inch) and used one for each direction of running. The rails are of girder type weighing 87 lbs. per yard, jointed by Dick, Kerr & Co.'s "Dicker" joint; the joints are bonded with No. 0000 "Neptune" bonds, and cross-bonded every 120 feet. The gauge is standard, 4 ft. 8½ in. There are nine double-decked motor cars fitted with Brill 21 E. single trucks, with two 25-H.P. motors to each car, and controllers of the solenoid blow-out pattern. There are on order six single-decked cars. The double-decked cars have a capacity of twenty-passengers inside and thirty-four outside, and the single-decked cars will carry thirty-two passengers. There are no grades of importance on the line, and the cars are fitted only with hand-brakes, and, for emergency, arrangements are made for short-circuiting the motors. The lighting station has been run since 1891 by the Corporation, but the tramway has only just been opened. G. H. B.

2335. *Power Transmission at Mescla, France.* (Elect. World and Engineer, 36. pp. 159–161, Aug. 4, 1900.)—This station has been laid down to supply the tramway system which is linking together the towns along the Riviera from Cannes to Mentone. The generating plant consists of three 500 kw. three-phase alternators, each flexibly coupled to a separate turbine. The machines have twenty poles and deliver current at 10,000 volts and twenty-five periods. The turbines are of the centripetal type, with twin conical wheels governed by regulators of the Escher Wyss oil-pressure type. The aerial line consists of six wires, each of 7·5 mm. diam., supported on triple petticoat insulators attached to 35 to 40 feet iron lattice poles, spaced 110 to 130 feet apart. At one place there are two spans of 230 feet each. It may be mentioned that a great deal of the material had to be transported on mule-back over rugged mountain-paths; in some places even the water for mixing cement in which the poles are fixed had to be so carried.

On the eighteen miles of line between Mescla and Nice, the drop is 10 per cent. There are three substations, the principal at Saint Agathe, transmitting current at 5,000 volts (six 55 kw. transformers) through lead-covered cables to subsidiary substations at Californie for the Cannes tramways, and at Beaulieu for the Monte Carlo tramway. The Saint Agathe substation contains steam plant consisting of two 700-H.P. double cylinder Corliss engines belted to the motor generators. These motor generators consist of a 530 kw. 9,000-volt synchronous motor, direct connected to a 500 kw. 550-volt compound railway generator running at 300 r.p.m. There are also in this substation two rotary converters with six 20 kw. static transformers, and a small 35 kw. motor generator with its three transformers, which delivers current at 75 volts and serves to boost the lines running to Contes.

The low-tension feeders are nearly all underground, of armoured cable, 0·31 to 0·62 square inch cross-section. In order that the municipal regulations regarding electrolysis may be adhered to, a complete system of pilot wires has been connected to all the important parts of the line.

The rolling stock of the system will comprise one hundred motor cars and many trailers, twenty-two express or freight cars, and three electric locomotives. The cars are made so that they can take current from the trolley wires or from the slot conduit which is employed in the central part of Nice.
E. K. S.

2336. *Power Station of the Berlin Tramways.* (Engineer, 89. pp. 546–547, May 25, 1900.)—The three engines at the central electric power station are of the marine type, with triple expansion, and were made by Sulzer Brothers. They have one high-pressure, one intermediate, and two low-pressure cylinders, arranged as twin vertical tandems coupled at 180° with two flywheels. The diameters of the cylinders are 34 inch, 49·2 inch, and 61 inch, and the stroke is 51·2. With a steam pressure of 176 lbs. per square inch and a speed of 85 r.p.m., the H.P. is 1,740 with a cut-off at 0·11 of stroke, and 3,860 with cut-off at 0·5. The steam being superheated, jackets are provided only for the intermediate and low-pressure cylinders. Special care has been taken to secure rigidity in the framing and to minimise vibration. Double-beat puppet valves are used, fitted in the cylinder covers and suspended by double sets of plate springs. All the valve-rods are tubular. The Porter governor is completely enclosed so that it may be continuously lubricated; and the adjustment of the central sliding weight is effected by altering the amount of water in a small tank attached to a lever. Steam is supplied by eight water-tube boilers, each having 303 square metres of heating surface. There are two Schmidt superheaters with independent firing. The dynamos are 16-pole direct coupled, and develop 1,000 kw. at a pressure of 250 to 280 volts. About four tons of copper are used in each, liberal air spaces being allowed in order to diminish armature reaction. The dynamos are connected two in series across the mains.

The efficiency (E.H.P. to I.H.P.), as found from various tests, ranged from 82·6 per cent. to 85·6 per cent., the E.H.P. being about 2,500. The steam consumption per H.P. hour was 9·5 lbs., with a superheat of 113° C., and 11·7 lbs. with saturated steam. The coal consumption amounted to 2·1 lbs. per kw. hour in the former case, and 2·3 lbs. in the latter. W. H. E.

2337. *The Boston Elevated Railway.* **C. B. Fairchild.** (Street Rly. Rev. 10. pp. 121–130, March; 185–195, April; and 246–256, May, 1900.)—The track, which is double throughout, is partly elevated (for six miles), partly subway, the two being connected by inclines. It crosses the Charles River on the upper deck of a large drawbridge, which, with the approaches, constitutes an interesting feature of the system. Details are given of the elevated structure and its foundations. Where the shadows of the plate cross-girders would be objectionable, lattice girders are used. The draw-span (illustrated) over the Charles River is 240 ft. long, 100 ft. wide, and 23 ft. above high-water mark. It provides for two 29-ft. roadways and two 10-ft. side paths, in addition to the double car tracks. The revolving mechanism is within the circular base of a central pier, 54 ft. in diameter. The load is supported on solid steel wheels placed close together. Two electric motors are used for rotating the bridge, and two hydraulic lifts at the ends of the structure lock and help to support its ends when closed. A section of the track on the elevated structure is given. The conductor rail is supported at one side of the track on insulating blocks and is made of ordinary 85-lb. track rails connected by continuous joints.

Rolling Stock.—The cars for the elevated railway are 46 ft. by 8 ft. 6 in. overall, and will have side as well as end doors. A train will consist of two to five cars controlled on the "multiple-unit system," so that all the motors can be operated from any one platform. Three trains of four cars each will be experimentally equipped with different electric systems. Three cars of the type described will be equipped with two 150-H.P. motors, both mounted on one truck, the first with General Electric motors and system of multiple control, the second with Westinghouse motors and method of control, the third with the Sprague system, and each will draw a train of loaded goods trucks. Various automatic air brakes and electric car heaters will be tried at the same time.

The Boston Subway, originally built by the city to relieve congested streets, is 9,500 ft. long. It is approached by open inclines leading down from the streets with gradients at 5 to 8 per cent. Sections of the subway and approaches are shown. An objection from a passenger standpoint is the excessive noise caused by the echo from the walls, due probably to the trolley wheels. The number of passengers through the subway during the last fiscal year was 233,136,939, the earnings being $9,671,441 and the operating expenses $6,827,150.

Power Stations.—Power for the entire system is supplied from seven stations having a total rated capacity of 26,144 kw., which may be safely overloaded to the extent of 25 per cent. The central power station, recently remodelled, contains a vertical cross-compound condensing engine rated at 4,000 H.P., but capable of working up to 7,000 H.P. The cylinders are 42 in. and 90 in. with 60-in. stroke, and the speed is 75 r.p.m., with a 28-ft. flywheel of the spoke type. The top of the frame stands 34 ft. above the floor. The engine is direct-coupled to a 2,700 kw. generator, which was commenced by the Walker Co. of Cleveland but finished by the Westinghouse Co. It was the largest machine that had been designed. The total weight is 300,000 lbs., the armature is 16 ft. 6 in. in diameter, weighs 115,000 lbs., and is mounted on a 37-in. hollow forged nickel-steel shaft made by the Bethlehem Steel Co. The outside diameter of the commutator is 8 ft. 9 in. The field-magnet frame is of cast steel and provided with hand-holes. The poles are of laminated wrought iron, bolted into the frame, the hand-holes giving easy access to the bolts which hold the poles in place. The normal load of the generator is 4,500 amperes at 600 volts, or sufficient to operate 300 loaded street cars. The condensing plant of this engine is of interest, as it dispenses with the usual air-pumps, and forms and maintains its vacuum entirely by the use of the exhaust steam and the condensing water. It consists of two Buckley injector-condensers attached to the main exhaust-pipes. The exhaust steam enters a hollow cone of moving water at the upper part of the condenser, and in condensing imparts to it a velocity which enables it to carry out the air and vapour into the enlarged port of the condenser below. The condensers are connected to the hot well by air-tight water discharge-pipes of sufficient length to allow the water to be delivered by gravity against the pressure of the atmosphere. Circulating water is supplied by an electrically driven centrifugal pump, and after the vacuum is formed the water is raised 25 feet by atmospheric pressure, thus giving the pump little to do. Automatic relief valves are provided to allow the engine to work non-condensing the instant the vacuum is lost from any cause.

The central power station had originally six triple expansion engines belted through countershafting to multipolar 500 kw. generators. In 1896 these were enlarged to 1,600 H.P. and direct-coupled to General Electric generators. Two of these give 1,350 kw. each and four 1,200 kw. each. There are also two 2,000-H.P. engines direct-coupled to 1,500 kw. generators. The engines are of the Reynolds-Corliss type, made by the E. P. Allis Co. The boiler equipment includes 8 double-decked and 24 single-decked Babcock boilers. An elaborate coal-handling equipment is provided, consisting of a bridge-crane having at the canal end a cab and 80-H.P. motor, which operates ropes controlling a shovel of the oyster-shell type. The coal is piled over wooden tunnels, into which the coal cars run and are filled through chutes. The mining train which supplies the central station is run direct in front of the boilers after being weighed, and the coal dumped down without shovelling. The last new station is the Harvard Power Station, completed in 1898. The boiler equipment consists of six 500-H.P. Babcock boilers, with economisers and smoke-stack for twice this number. The boilers are fitted with "Acme" stokers, these being the only mechanical stokers used by the Boston Elevated Co. The three main engines are of the compound Corliss type by Allis & Co., direct-coupled to 1,200 kw. General Electric generators.

Rolling Stock.—There are 1,881 closed passenger cars and 1,892 open cars, in addition to 11 mail cars, 2 electric locomotives, 4 service cars, and 1 directors' car; 150 closed passenger cars and 50 12-bench double-deck cars are on order. The miscellaneous equipment includes 188 snow-ploughs. Photographs of the cars and ploughs are given.

Testing Motors.—This is done by the Hopkinson method, a flexible coupling being used to save time in aligning the shafts. Temperature rise and efficiency are determined, liquid rheostats being used with a solution of soda. Temperature rise is electrically determined by the rise in resistance, 1 per cent. increase in resistance being taken as equivalent to 2·5° C. rise in temperature. In order to accurately test the consumption of power while the car is in active service, 60 cars are fitted with wattmeters. The rail-joints are periodically tested by comparing a 3-ft. length of rail, including the joint, with an unbroken length of rail [see Abstract No. 770 (1900)]. The standard size for the trolley wire is No. 0. Owing to the physical conditions, a direct-current system with a number of power-houses properly distributed was preferable to a high-pressure system with a single power-house and transformer-stations. In computing the copper required to give the most economical results for the feeders, the engineer followed a method devised by himself, which was published in the Review for July, 1897. The insulation of the overhead feeders is chiefly of tarred jute, and of those underground, rubber or paper according to the soil. The insulation resistance of the underground cables varies from 200 to 1,500 megohms per mile. The drop in potential varies on the lines from 10 to 15 per cent., except on one or two of the longer lines, where it reaches 20 per cent. In ordering cables or wires, the specification as to purity states that the resistance shall not exceed 0·1157 ohm per mile of 500,000 circ. mils. section. The underground conduits have been constructed both of terra-cotta ducts laid in cement and of cement-lined iron tubes. In moist ground the manholes are built with double walls, with waterproof paper between.

The Street Railway Co. is required by City ordinance to remove all the snow from the streets in the business districts where cars run; this work is difficult and has to be elaborately systematised. E. H. C.-H.

2338. *Deering Harvester Company's Power Station.* (Amer. Electn. 12. pp. 371–379, August, 1900.)—The Deering Harvester Co.'s factory in Chicago consists of buildings occupying 85 acres and containing machinery absorbing 7,500 H.P. In 1898 a 1,000-H.P. three-phase alternating set was laid down, which is now replaced by a large central station designed for 10,000 H.P. The system used is three-phase alternating current at 600 volts. The boiler-room is designed for 13 water-tube boilers, each of 700 H.P., having 10 sq. ft. of heating surface per H.P. The feed-water is heated by a 4,000 H.P. Cochrane feed-water heater and purifier, and also passes through Hoppes feed-water purifiers. It is heated to a temperature of 360° F.

The engine-room contains three Allis-Corliss vertical two-bearing cross-compound engines of 1,100 kw., running at 90½ r.p.m. The cylinders are 28 and 60 in., with stroke of 48 in. The engines exhaust into a central condensing plant of 5,400 H.P., giving a vacuum of 26 in.; the condenser is a Weiss counter-current jet condenser. Each engine drives directly a General Electric revolving-field three-phase generator between the two cranks of the engine, giving 1,060 amperes per phase at 600 volts. It is cable-wound, with a continuous winding in six slots per pole. The frequency is 40 periods. The exciters are run by independent engines. On the switchboard eleven feeder panels supply different sections of the factory. Circuit-breakers are used instead of fuses. General Electric type induction-motors are used throughout the factory, belted to line shafting; the larger motors are started with a water-resistance, but their rotors are in permanent short-circuit. A starting test on a 75-H.P. motor running light on the shafting showed a momentary rush of current of nine times the full-load current when thrown on the mains without, and but four times with the water-resistance. G. H. B.

2339. *Power Plant of the Western Electric Company's Factory.* (Amer. Electn. 12. pp. 338–338, July, 1900.)—The Western Electric Co. has put down a power plant of an aggregate capacity of 1,550 kw. for supplying power and light to its New York factory.

The system is continuous current at 120 volts. There are two boiler-rooms; the old one contains Babcock and Wilcox boilers for 1,200 H.P., the new one for 1,250 H.P. Steam is supplied at 140 lbs. per square inch. The feed-water is heated by Green economisers. The new boilers are fitted with induced-draught blowers. Coal is delivered from waggons through a chute below the street to an endless conveyer taking it to storage and service bins; from these it is shot into weighing hoppers moving on an overhead track in the boiler-room. Ashes also are removed by the conveyer. The engine-room contains four Ball & Wood Corliss-type vertical cross-compound engines running at 150 r.p.m., each of 350 kw.; also two similar engines of 100 kw. and 50 kw. taking steam at 100 lbs. per square inch through a Foster reducing valve. Independent steam-driven Conover jet-condensers and air-pumps are used.

Each large engine drives directly a Western Electric multipolar dynamo, giving 2,900 amperes at 120 volts, capable of an overload up to 4,000 amperes.

The interior wiring in the building is in iron-armoured conduits. The output during the day varies from 7,500 to 8,000 amperes, the greater part of which is motor-load. The motors are in all cases belted to shafting. The efficiency of the plant is 260–270 watt-hours delivered per pound of pea-coal.
G. H. B.

2340. *Power Station of the North-Western Elevated Railroad, Chicago.* (Street Rly. Rev. 10. pp. 369–375, July, 1900.)—The ultimate capacity of the station will be 14,000 H.P., and of this 7,200 H.P. is now installed. The completed building will be 430 ft. long by 110 ft. wide, with the chimney-stack in the centre. This stack is 217 ft. high and 16 ft. internal diameter, the inner fire-brick shaft being 110 ft. high.

The boiler-room contains twelve Babcock & Wilcox water-tube boilers set in batteries of two, fitted with extended front Murphy automatic smokeless furnaces. The live steam-pipes are extra heavy lap-welded of wrought iron, the exhaust-piping being of cast iron. The steam valves are of the bronze-seated gate type of the Chapman make. The exhaust is ordinarily led to a Weiss central condenser, in which the air-pump is an air compressor of an improved type, working free from water, and the circulating pump of the Bibus rotary type, handling only the cold injection water. When the condenser is not working, steam is taken above the roof through a 40-inch diameter free exhaust-pipe. The feed-water is heated by two Berryman feed-water heaters, with a capacity of 2,000 H.P. each; the water is forced through these by means of three Duplex pumps of the vertical type by Worthington. All the feed-pipes are in duplicate.

The engine-room contains three engines made by E. P. Allis & Co., of the cross-compound condensing type, fitted with Corliss gear, and driving direct Siemens & Halske 1,500 kw. generators. The diameter of the cylinders are 30 in. and 60 in. respectively, with a stroke of 5 ft.; the speed is 75 r.p.m. In addition to the large sets there is also another one of 750 kw. capacity, similar to the above, the cylinders being 28 in. and 46 in. diameter and the stroke 4 ft.

The shafts are made by the Bethlehem Steel Co., and are of fluid compressed open-hearth steel, hollow forged over a mandril. For the large engines the shafts are 28 in. and 22 in. diameter at the flywheel and the bearings respectively, the bore being 8 in. diameter. The flywheel of the large engines is 25 ft. diameter, the small engine 20 ft., and each engine has two governors, one regulating the cut-off in both cylinders, and the other to trip a safety cut-off when the safe speed is exceeded.

The switchboard is two-decked, the station panels being below and the feeder panels placed above. Coal storage is provided up to 1,500 tons, the bunkers in the boiler-room holding another 300 tons. The capacity of the conveying system is 50 tons per hour, the ashes being also removed by means of a conveyor.

The article is well illustrated by sixteen figures, and very full details are given of the piping, receivers, and Weiss condensers, and other mechanical details. E. K. S.

2341. *Electrical Equipment of the Indian Head Smokeless Powder Factory.* (Elect. World and Engineer, 36. pp. 275–278, Aug. 25, 1900.)—System: Double-current generators, supplying direct current for traction and two-phase alternating current for lighting and motive power. The engine-room contains two compound enclosed Westinghouse engines of 500 H.P. each, with cylinders 20 and 34 inches diameter, 16 inches stroke, and one of similar type of 150 H.P., with cylinders 12 and 20 inches diameter and 12 inches stroke. Each engine drives directly a Westinghouse generator. The two large machines are each of 250 kw. output, delivering direct current at 550 volts from the commutator, and two-phase alternating current at 400 volts and 60 periods. The small machine is rated at 75 kw., delivering two-phase current only, at the same pressure and frequency as the others. The exciters are driven by belts from the shafts of the generators. A transformer of 18¾ kw. capacity is used to raise the pressure to 1,100 volts for a long lighting feeder. The double-current generators are run in parallel on either system, and with the alternator if desired; they are provided with series field coils, which do not interfere with paralleling. Induction motors are used for driving the machines in the factory, the absence of commutators being a feature of the first importance in the manufacture of explosives. The tramway is equipped on the overhead trolley system, except for a distance of about half a mile, where it crosses the gun ranges; to prevent damage from projectiles this part of the track is equipped with the Westinghouse electromagnetic surface contact system, which is described in detail. The rails are of the flanged type, weighing 56 lbs. per yard. There are two 100-H.P. freight locomotives and a 70-H.P. combined passenger and freight car. The locomotives haul a load of 30 to 40 tons, and pass from the trolley to the surface-contact system without stopping. The system has operated with complete success. A. H. A.

2342. *Power Transmission at Lindsay, Canada.* (Canad. Elect. News, 10. pp. 89–93, June, 1900.)—A fully-illustrated description of this electric power transmission scheme, whereby power is derived from the Fenelon Falls on the Scugog River. Current is generated by a 400 kw., 500 volt, three-phase generator, direct coupled to a pair of 40-inch Samson turbines. The generator pressure is transformed to 11,600 volts for the overhead transmission line to Lindsay, distant about fourteen miles, where the energy is utilised for the usual lighting and power purposes of the town. E. D. P.

ELECTRIC TRACTION AND AUTOMOBILISM.

2343. *Electrolysis from Earth Returns.* **G. Claude.** (Soc. Int. Élect., Bull. 17. pp. 238–250, June, 1900. Additional Notes, pp. 251–260.)—After briefly reviewing previous researches on the electrolytic phenomena met with in electric traction due to the return currents, the author outlines the accepted theory as to the path of the currents, which has given rise to the regulation that the fall of potential in the rail return shall not exceed 5 volts—a safe and effective rule. Certain experiments made by the author, however, show that the relation between the earth current and the difference of potential to which it is due, agrees almost exactly with Ohm's law, which would not be the case if the conduction were electrolytic. Upon applying a difference of potential between the rails and neighbouring water-pipes equal to that met with in ordinary working, large currents were found to flow through the earth; but when the actual currents flowing in the pipes were measured directly, their values were ascertained to be only $\frac{1}{30}$th or $\frac{1}{50}$th of those above mentioned. Thus it was shown that by far the greater part of the stray current flowed through the earth, not through the pipes; moreover, the author estimates that the stray currents amount to from 12 to 30 per cent. of the total current returning to the station, while in most cases the current flowing in a pipe does not exceed a small fraction of an ampere. These results are contrary to what was formerly supposed to be the case. By passing a known quantity of electricity between leaden plates buried in the ground the author ascertained that the actual corrosion was far below the theoretical value, and when the difference of potential was only about 1 volt, the loss of weight was only $\frac{1}{25}$th of the calculated value. Tests made by Herrick with iron plates (Street Railway Journal, May, 1900) give exactly similar results. By using several return feeders, or even by spreading out branches of equal resistance from the end of a single feeder to several widely separated points on the rails, bunching of the stray currents to one point can with great advantage be prevented. The same end can be attained by connecting the negative pole of the generators to the trolley wire and the positive pole to earth. The stray currents flowing from pipes to rails will then be distributed over a large area, and consequently weakened in intensity at any one point. The author concludes by approving of the Board of Trade rule that the potential difference between rails and pipes shall not exceed 1·5 volts, and considers that to connect the pipes to the rails near the return feeding-point is a harmful practice.

In the notes appended to the paper the author gives details of the tests carried out by him, showing the close proportionality between the stray currents and the potential differences to which they are due, the unexpected magnitude of the currents, and the superior conductivity of gas-pipes compared with water-pipes. The method of measuring the currents flowing in a pipe consists in applying a voltmeter between two points in the pipe about 100 yards apart, and obtaining the reading e_1, then immediately repeating the reading when the same points are shunted by a low resistance, giving e_2. The current i flowing in the shunt is measured with an ammeter. The ratio $e_1/(e_1 - e_2)$ is a constant, which, multiplied by the maximum current observed, i, gives the maximum current flowing in the pipe. The accuracy of the method is discussed, and examples of its application are given. The mode of measuring the total return current is also explained. The author recommends the Falk (cast-weld) bond in place of copper bonds. By connecting the pipes to the rails the stray currents in the former are multiplied, it may be, a hundredfold, with consequent danger of corrosion at bad joints in pipes, although the current does not leave and re-enter the pipe at a joint, but over a considerable length on either side of it. This being so, it is better not to connect the rails with the pipes. A. H. A.

2344. *Rail Bonds.* (Tram. Rly. World, 9. pp. 369–372, Aug., 1900.)—A description of the various bonds which are now in use, viz.: The Chicago, Chicago Crown, Falk cast-iron weld, Lorrain Steel Company's electric weld, and the various bonds in which the Edison-Brown plastic alloy is used, *i.e.*, the original cork type, the plastic plug, and the copper plastic bond of H. P. Brown.

A bond to be of permanent use must be absolutely reliable as regards conductivity, and the Falk cast bond sometimes fall short of this owing to blow-holes. It is, however, much used. In making the cast-iron bond it is important that before fixing the moulds, the sides and bottom of the rails should be cleaned with an emery-wheel or sand-blast. The cast-iron, which is run in at much greater heat than in ordinary casting, cools rapidly on the outside surface, thus causing a tremendous pressure to be exerted on the molten metal still in contact with the web and foot of the rails. As the metal is poured from one side and comes in contact with the web or thinnest part of the rail at its greatest heat, this part of the rail is brought to a white heat, and owing to the tremendous pressure the cast iron is practically forced into the interstices of the steel, as is shown by the fact that if torn away from the web of the rail it usually brings away part of the rail with it.

In fixing the plastic bond, the contact spots are cleared of rust and scale by a heavy, broad-pointed track-drill, or a specially designed emery-wheel, moistened with soda and water (oil must never be used). The following tests show the low resistance obtained :—

	Amps.			
	100	500	1,000	1,500
Ordinary single plastic bond on 60-lb. rail, volts drop..	·004	·02	·04	·06
Ordinary single plastic bond on 90-lb. rail, volts drop..	·004	·0095	·017	·04
Plastic plug bond on 60-lb. rail, one pair of $\frac{5}{8}$-inch holes, volts drop..................	·005	·025	·05	·086

Plastic bonds put down in Dublin five years ago, which have been recently taken out, show as good a contact as on the day they were put in.

The material has remained perfectly soft, and the contacts are still quite bright. Experience on the Boston Elevated Railroad after two years, and the Metropolitan West Side Elevated Railway of Chicago after three years' use, bear out the same result. The plastic bond gives almost equal conductivity to that of the rail, the cost being but slightly higher than the usual copper bonding, which only secures a joint having a conductivity of $\frac{1}{2}$ to $\frac{1}{8}$ that of the rail. E. K. S.

ELECTRIC LAMPS AND LIGHTING.

2345. *Arc-Lighting from a 250-Volt Supply.* **W. B. Sayers.** (Inst. Elect. Engin., Journ. 29. pp. 382–393, April, 1900.)—The introduction of 250–500 volts supply pressure in Glasgow has led the author to go into the question of economical arc-lighting for such circuits.

Enclosed arc-lamps are obtainable which burn singly across 250-volt circuits, but the energy consumed per c.p. hour is very great, and the colour of the light is unsatisfactory with these lamps. The usual methods of many lights in series, and the dissipation of energy in resistances are discussed. The relative merits of enclosed—and open—arc lamps are next considered, and the following table of comparison, representing the results of tests made by the author, is given :—

	Open-type Arc.	Enclosed-type Arcs.		Incandescents (new lamps), Clear Globes.			
	5 in Series. S.R. = 4 ohms. C=10Amps Watts=500	2 in Series. S.R. = 12 ohms. C=4 Amps. Watts=500	Single. C = 2·75 Amps. Watts=680	16, 16-c.p. C = 4·4 Amps.		31, 8-c.p. C=4·5 Amps.	
				Watts =1,100	Watts = 500.	Watts =1,120.	Watts = 500
Relative Luminosity	1	0·475	0·1	0·68	0·31	0·75	0·333
Do., do.	3·25	1·54	0·325	—	1	—	1·07

Note.—Voltages across lamps and resistances = 250.

The 250-volt enclosed lamp does not meet the difficulty, inasmuch as it gives about one-third the light of a group of incandescents and one-tenth the light of an open arc lamp, all consuming energy at the same rate.

Where a sufficient number of lamps is required, there are two methods of overcoming the difficulties: (1) The use of a transformer to reduce the supply pressure to a suitable voltage for running single lamps in parallel; and (2) the use of a special "ganger" switchboard devised by the author. The latter method consists in running a separate pair of leads from each lamp to a pair of plug connections; plug and socket connections are provided whereby the number of lamps required are put into circuit in series with each other, in groups of four or five, and any set of lamps which is incomplete is run with a series resistance to correspond to the full complement of lamps. The disadvantages of this system are that means of communication with the switchboard by bells, telephones, or speaking-tubes would be required, and that all lamps would have to be of the same size so as to be interchangeable. A method somewhat similar to this has been in use at St. Pancras Station by the Midland Railway Company for some years.

The best method, where a number of lamps is required, is the use of a step-down transformer with the lamps simply in parallel on the secondary circuit. The advantages of this system are: Each lamp would be under independent control, and consequently burning economically; the size of any lamp may be fixed according to requirements; the exact number of lamps required may be fixed; and the voltage at each lamp terminals may be adjusted for the best results. The first cost of, and the electric loss in, the transformer are the chief drawbacks, but are more than outweighed by the general advantages and economy of the method. It is suggested that the Supply Company should bear the loss in the transformer by fixing the meter on the low-pressure side, the consumer to pay the first cost of the transformer. With regard to the best pressure to be used on the secondary side of the transformer, the author submitted three questions relating to this matter to several well-known arc-lamp manufacturers. The answers to these questions are given in full.

The paper concludes with two sets of curves. The first one shows the cost of running sets of five lamps in series on circuits. The second set shows the results of using the transformer system. E. D. P.

2346. *Comparison of Open and Enclosed Arc Lamps for Street Lighting.* **H. H. Wait.** (Amer. Electn. 12. pp. 274–276, June, 1900.)—The author states that the enclosed lamp has practically driven the open arc from the field for constant-potential circuits; and that, for alternating circuits of either class, open arcs are no longer considered. The author briefly discusses in a general manner the results which have been obtained from time to time in tests of open and enclosed lamps by various people; the distribution of light, the deposit inside globes and its effects, the absorption of globes, the colour of the light, the watts per mean hemispherical candle-power, and so forth, basing his remarks on the requirements of street lighting. Polar curves are given of the mean results of various tests on open and enclosed arcs, and also a curve showing the variation, according to distance from the lamp, of the intensity of illumination at the street surface.

The following table of figures dealing with the relative operating expenses of lamps is given:—

Operating Expenses per Lamp per Year of 3,800 hours.

	Open direct-current trimmed daily.		Open direct-current double carbon, alternate days.		Enclosed direct current.		Enclosed alternating current.	
Trimming	$7·30	$11·00	$4·50	$6·50	$2·50	$3·15	$4·70	$5·80
Carbons	7·30	7·50	6·50	6·80	1·50	1·70	2·00	2·30
Outer globes	·40	·70	·30	·50	·25	·25	·30	·40
Inner globes	......	......	......	......	1·00	1·05	1·30	1·40
	$15·00	$19·20	$11·30	$13·80	$5·25	$6·15	$8·30	$9·90

It is then shown that the saving of nearly $10 per lamp by using enclosed instead of open arc lamps for all-night running would be a complete gain if the installation be a new one; or the change may be more or less profitable if radical changes are being made at the generating station. The author estimates the cost of changing from several small 10-ampere machines operating open arcs to large 6·8-ampere units operating enclosed arcs at $30 per lamp;

in which case, the change being so expensive, the author concludes that the bulk of the saving must take place in the increased efficiency of the generating plant. The saving in operating expenses brought about by the change in generating plant may frequently be very high and the advisability of the change must be figured out accordingly [see also Abstract No. 1201 (1900)].

E. D. P.

2347. *Photometric Value of Arc Lamps.* (Elect. World and Engineer, 35. pp. 824–826, June 2, 1900.)—This is a report presented to the National Electric Light Association (U.S.A.) by **C. P. Mathews,** who performed the photometric work and evolved the methods and devices used. Briefly, the improved methods introduced are as follows: The use of two mirrors instead of one for directing the light from its source to the photometer. These mirrors are placed on opposite sides of the arc and render the illumination of the photometer disc more uniform. The use of a rotating disc with sectors, which reduces the effect of colour difference. The recording drum used to correct retinal fatigue was improved by the addition of an electromagnetic recorder. Particulars of these devices and of the arrangement of the apparatus are given.

With an opalescent inner globe the globe itself becomes luminous by diffusion, and this effect changes with the position of the arc within the globe. Tests were made, using the same inner globe and the same pair of carbons, but with the arc at certain definite heights inside the globe—in each case the arc being placed at the centre of the mirror system. The largest amount of light was obtained with the arc at the mid-point. The causes of this are pointed out, the question resolving itself into a subject for investigations as to the carbons used, shape of globes, &c. Curves are given showing the results obtained with three different lengths of the lower carbon. The report includes the discussion of tests obtained with eight different makes of 110-volt, direct-current, enclosed lamps. They were tested just as sent from the makers, under uniform conditions as follows: The same brand of carbons throughout; an opalescent or milky inner, and clear outer globe, as supplied; an opalescent inner and opalescent or milky outer globe, as supplied. Curves are given and discussed. Some of the results are as follows:—

At a common terminal E.M.F. of 110 volts, seven of these lamps take an average current of 4·90 amperes, which means an average total power consumption in each lamp of 539 watts. With 80 volts at the arc, this power is divided into 147 watts wasted in the resistance coils and 392 watts in the arc. The average yield of light, expressed as mean sperical intensity is—

Opalescent inner, no outer = 256 H.U.
Opalescent inner, clear outer = 207 H.U.
Opalescent inner, opalescent outer = 177 H.U.

Hence the power required to produce one unit of light in this type of lamp is—

Opalescent inner, no outer = 2·10 watts.
Opalescent inner, clear outer = 2·66 watts.
Opalescent inner, opalescent outer = 3·04 watts.

Similar tests were made with seven different makes of 110-volt, alternate-current, enclosed lamps. Curves are given and a summary of the results.

The mean power consumption of the seven lamps was 417 watts. The average value of the mean spherical intensity is—

With clear outer globe	159 H.U.
With opalescent outer globe	130 H.U.

Therefore, as light producers, the average efficiency is—

With clear outer globe	2·62
With opalescent outer globe	3·20

reckoning in watts per mean spherical Hefner unit. The mean power in the arc is 342 watts, and in the mechanism 74 watts.

Comparisons are drawn, based on the results obtained, between the direct-current and the alternate-current lamps as sources of light. The effect of the coating of ash on the inner globe is discussed, and the following table of the averages of the whole set of experiments is given, the first part relating to direct-current and the second part to alternate-current lamps.

No.	Current.	Watts Consumed					Mean Intensity in H.U.			Mean Watts Per		
							Spherical.		Lower Hemi-spherical.	Spherical H.U.		Lower Hemispherical H.U.
		In Lamp.		In Arc.		Mechanism.	Op. Outer.	Clear Outer.	Clear Outer.	Op. Outer.	Clear Outer.	Clear Outer.
1	5·01	551		401		150	172	235 256[1]	332 362[1]	3·10	2·37 2·18[1]	1·66 1·52[1]
3	5·08	559		406		152	195	216	282	2·85	2·60	1·99
4	4·76	524		381		143	127	139	208	4·12	3·76	2·52
5	4·16	458		333		125	154	174	221	2·96	2·63	2·07
7	4·76	524		381		143	203	233	317	2·63	2·20	1·65
9	4·84	532		387		145	182	226	281	2·83	2·38	1·89
10	4·99	549		399		150	202	242	309	2·74	2·24	1·77
12	4·87	536		390		146	178	195	230	3·05	2·66	2·33
	4·9	529		384		144	176	207	272	3·03	2·60	1·98
			Power Factor Lamp.		Power Factor Arc.							
101	6·40	448	·63	340	·82	108	127	141	206	352	317	2·17
102	6·79	459	·61	375	·73	84	146	203 176[2]	236 266[2]	3·31	226 260[2]	1·94 1·72[2]
103	5·89	424	·65	344	·75	80	116	130	147	3·66	3·15	2·88
105	6·20	414	·61	382	·80	32	128	187	219	3·24	2·20	1·89
106	6·12	378	·56	298	·70	80	132	153 152[2]	169 254[2]	2·82	2·56 2·49[2]	2·23 1·48[2]
108	6·48	457	·64	383	·80	74·5	133	175	211	3·30	2·61	2·16
110	6·18	339	·49	276	·72	63	140[1]	126	143	2·41[1]	2·68	2·37
	6·29	417	·60	342	·76	74·5	130	159	190	3·31	2·66	2·23

[1] Condition of no outer globe.

[2] Condition with shade on lamp.

E. D. P.

2348. *Hackl Alternate Current Arc Lamp.* **de Lénart.** (Soc. Int. Élect., Bull. 17. pp. 235–237, June, 1900.)—In this lamp, which is made by Ganz & Co., nearly the whole of the light emitted is utilised in lighting the lower hemispherical zone. The essential feature of the lamp consists in that the carbons are inclined to the axis of symmetry of the lamp at an angle of 45°, and are, therefore, at an angle of 90° to each other. Each carbon is supported by a rack connected to a train of gearing controlled by a lever. The two-toothed wheels, belonging to the two carbons, are connected by a common wheel, the arbor of which bears an aluminium disc. The regulating system comprises a series electromagnet. In its movement in one direction or the other, the brake-lever locks the disc, or allows it to rotate. The carbons are cored and flattened at their upper side so as to prevent change in the position of the arc. These lamps work at 30 volts and 10–16 amperes. A 12-ampere lamp consumes 360 watts; the regulating rheostat in series, 60 watts on a 105-volt circuit; a distributing apparatus for enabling three lamps to work in parallel consumes 30 watts; the light of each lamp is equal to 500 candles, so that one candle corresponds to 0·86 watt, which is the commercial efficiency. Since only 347 volts are consumed by the arc itself, the efficiency thereof is 0·69 watt per c.p. C. K. F.

2349. *Street Lighting with Arc Lamps.* **A. L. Rice.** (Amer. Electn. 12. pp. 379–380, Aug., 1900.)—The author discusses various systems of lighting with alternating arc lamps, with or without transformers and inductance coils. A table is given showing the comparative results with transformers and inductance coils respectively; in the former case an enclosed lamp taking 450 watts in the arc, 613 altogether, costs £32·3 to instal and £12 per annum to run, with a power factor of 0·78; and in the latter case, the same lamp takes 598 watts in all, costs £32 to instal and £11·2 per annum to run, the power factor being 0·89. A. H. A.

2350. *Arc Lamps and Cost of Lighting.* **W. M. Stine.** (Amer. Electn. 12. pp. 327–330, July, 1900.)—In this paper the author gives the characteristic features, illustrated by curves, of direct and alternating current open and enclosed arcs, the efficiency of globes of different kinds of glass, and the following table, showing the relative costs of installation and operation of various types of arc lamps, viz.:—

Watts.	Enclosed Arcs.	Cost per Lamp.	Cost per Year.
400	Alternating current	$146·50	$52·86
450	„ „	155·24	57·85
300	Direct current	117·90	41·75
450	„ „	147·00	56·07
	Open Arc.		
450	Direct current	142·00	62·58

C. K F.

2351. *High-Voltage Lamps.* **A. Werner** and **J. Hardwick.** (Elect. World and Engineer, 35. p. 778, May 26, 1900.)—The authors have attempted to make lamps for 500 volts by combining infusible metals, such as iridium, osmium, ruthenium, and rhodium, with rare earths. The filaments were made by dipping threads into a mixed solution of one of the metallic salts and the nitrate of a rare earth. The carbon was burnt out by passing a heavy current. W. R. C.

REFERENCES.

2352. *Electric Railways.* (Zeitschr. Elektrotechn., Wien, 18. pp. 243–247, May 13, and 257–259, May 20, 1900; from the Zeitung des Vereines Deutscher Eisenbahn-Verwaltungen, No. 22, 1900.)—A general paper on the problems presented by electric traction on railways. The paper is accompanied by three tables giving statistics of persons carried, receipts, &c., on eleven lines worked by electricity in Hungary, nineteen lines in Austria, and one in Bosnia, some of the lines, such as the Budapesth Underground, Czernowitz, Pilsener, Saragevo, &c., carrying regular railway traffic. E. K. S.

2353. *Electric Distribution in Paris.* **J. Laffargue.** (Ind. Élect. 9. pp. 178–196, May 10, 1900.)—Particulars and statistics of the various companies.

2354. *Central Station Work.* (Amer. Electn. 12. pp. 259–274 and 277–278, June and July, 1900.)—A series of articles dealing with questions arising out of central station work. The various authors and the titles of their papers are as follows:—

R. C. Carpenter (pp. 259–260), The Selection of an Engine for a Power Station. **R. A. Douglass** (pp. 261–263), Boilers for Electric Power Plants. **J. F. Hobart** (pp. 263–266), Stoking in Central Stations. This article deals mainly with mechanical stokers, including the Wilkinson, Murphy, Roney, and Playford types. **J. Francis** (pp. 266–269), Handling Coal in Central Stations. **P. C. Percy** (pp. 269–270), Steam Plant Auxiliaries. A short article on the most economical method of driving feed pumps. **W. D. Ennis** (pp. 270–274, and 324–327). Arrangement of Central Station Piping. **L. B. Mather** (pp. 277–278), Electrical Equipment for Small Central Stations.

2355. *Electrical Equipment of Office Buildings.* **R. P. Bolton.** (Eng. Mag. 19. pp. 381–390, June, 1900.)

2356. *Tests of Controlling Systems for Electric Railways.* (Street Rly. Journ. 16. pp. 364–368, May, 1900.)—This paper describes tests made by the Boston Elevated Railroad Co. on the Sprague, General Electric, and Westinghouse controlling systems. Descriptions are given of the several systems, that of the General Electric Company being illustrated by diagrams and some detail drawings. This last-mentioned system is based on E. Thomson's U.S. patent No. 617,546. C. K. F.

2357. *Electricity Works in Germany.* (Elektrotechn. Zeitschr. 21. pp. 552–570, July 5, 1900.)—A list in tabular form of the various electric light stations in Germany, 652 in all, giving particulars about each.

2358. *Controller Diagrams.* (Street Rly. Journ. 16. pp. 459–460, June, 1900.)—Several of the diagrams, at present in use by the General Electric Company of America, are given, showing the complete wiring of the car.

2359. *Statistics of Electric Power Production.* **P. Dawson.** (Engineering, 69. pp. 434–435, April 6; 539–540, April 27; and 635–636, May 18, 1900.)

2360. *Preventing Fluctuations of Light.* **K. Schindler.** (Elekt. Runds. 17. pp. 182–183, June 15, 1900.)—In this paper, the various methods of preventing fluctuations of light on electric lighting systems are discussed, and an example given of calculating the dimensions of a fly-wheel for a dynamo. C. K. F.

2361. *Madras Electric Tramways.* (Tram. Rly. World, 9. pp. 132–134, April, 1900.)—This article fully describes and illustrates the overhead-trolley and tramway system of Madras. E. D. P.

2362. *Electric Traction.* **A. H. Binyon.** (Mech. Eng. 6. pp. 230–232, Aug. 18, and 275–276, Aug. 25, 1900. Abstract of a paper read before the Society of Engineers, June 11, 1900.)—A general discussion of the equipment of power stations and traction systems using the trolley. W. R. C.

2363. *Cost of Electric Power.* **P. Dawson.** (Engineering, 69. pp. 701–704, June 1; 739–740, June 8; and 841–845, June 29, 1900.)—An important article in which the author discusses the relation that may exist between the first cost of a plant and that at which power can be produced. The initial cost is taken to be made up of: (i.) Land and buildings; (ii.) Plant including all machinery in the station; (iii.) Mains, feeders, and distributors; (iv.) Miscellaneous apparatus, &c., including meters, instruments, cost of provisional orders, and such like.

In all thirty-four tables are given, illustrating various costs from actual results obtained in lighting and traction work in Europe and America. E. C. S.

2364. *Cost of Electric Power Plants.* **P. Dawson.** (Engineering, 70. pp. 112–113, July 27, 1900.)—The author seeks to show that the larger the plant, the nearer the costs as obtained from actual working results in various countries agree. Usually the costs are lower in a large than in a small plant. The cost of installation of the actual plant itself is examined in more detail than was the case in the author's previous articles (see preceding Abstract). E. C. S.

2365. *Indispensable Accessories of Electric Traction.* **H. E. P. Cottrell.** (Elect. Rev. 46. pp. 907–908, June 1; 965–967, June 8; 47. pp. 240–242, Aug. 10; 297–299, Aug. 24; and 492–494, Sept. 28, 1900.)—These articles illustrate and describe the American standard switchboard panels and connections, and also give data from various American switch catalogues. The average cost in pence of a single, double, and triple-pole single-throw switch can be found by multiplying the rating by 2, 3, and 4 respectively. For double-throw, the multipliers become 5, 9, and 13 (pp. 907–967). This is followed by a descriptive reproduction of the catalogue of Ward-Leonard enamel rheostats and a list of the apparatus on recent switchboards, put up by R. W. Blackwell & Co. (pp. 240–242). In the fourth article the switchboard list is concluded, and trolley wire and overhead line material is described (pp. 297–299). [See also Abstract No. 1985 (1899).] E. H. C.-H.

2336. *Burgdorf-Thun Polyphase Electric Railway.* **W. Rung.** (Elect. Rev. 47. pp. 576–578, Oct. 12; 615–616, Oct. 19; 695–697, Nov. 2; and 752–753, Nov. 9, 1900.)—Translated from Ingeniören.

2367. *Electric Railways in Italy.* **E. Bignami.** (Eng. Mag. 20. pp. 173–189, Nov., 1900.)—An article in popular form, giving general information about various Italian tramways.

2368. *Electricity in Mining.* **G. F. Walker.** (Feilden, 3. pp. 560–572, Nov., 1900.)—An article dealing with various electrical appliances, such as pumps, coal cutters, rock drills, locomotives, &c.

2369. *Electric-Lamps.* **A. Blondel.** (Écl. Électr. 24. pp. 464–471, Sept. 22, 1900. Paper read before the International Electrical Congress at Paris.)—A description of the progress in arc and glow-lamps, and of lamps with filaments other than carbon. A translation of the paper in abstract appears in Electrician, 46. pp. 54–56, Nov. 2nd, 1900. E. C. R.

TELEGRAPHY AND TELEPHONY.

2370. *Postel-Vinay Multiple Telephone Switchboard.* **J. Anizan.** (Journ. Télégraph. 24. pp. 169–173, Aug., 1900.)—This switchboard is shown at the Paris Exhibition, and provides for 15,000 lines. The panels are vertical, and the annunciators and ring-off drops, as usual, are above the jacks. In French boards the jacks are generally of "double rupture," so that the annunciators are completely isolated from the subscribers' circuits during conversation. However, the Administration permits of the employment of jacks in derivation, provided means are adopted for cutting out both annunciators when subscribers are in communication. In this system the annunciators are devised to meet this requirement. They are composed of two electromagnets placed one above another. The upper one serves for the call. That below is for the automatic restoration of the shutter. When the armature of this latter is attracted it opens two contacts, which are the terminals of the upper coil, and thus cuts it out of circuit. The current actuating the lower magnet comes into circuit when the plug is thrust home to the ring of a jack, the third conductor of the plug cord being joined to one pole of a battery, whose other pole is joined to the lower electromagnet, the other end of this magnet being connected to the ring of the jack. The isolation of the annunciator upon putting a plug into the jack constitutes an original feature in this switchboard. The same operation is performed upon the circuit of each subscriber. The ring-off annunciator alone forms a derived circuit when the listening-key is restored and subscribers are in communication. This has a higher resistance and greater self-induction than the calling-annunciator, and consequently hearing is good. Being the only annunciator in circuit the ring-off is certain. In these annunciators the armature of the upper coil maintains a curved lever in an upright position; this lever, which is hinged at its centre, has the subscriber's number plate at right angles to its lower end. When the armature is attracted the lever falls inwards, and the number plate is exposed. When the restoring coil below acts, its armature kicks the lever back to its position of rest. The "test" circuit is arranged as usual in connection with all the rings of the jacks. To ascertain whether a line is free or otherwise the operator touches the ring with the point of a plug, when a "click" is heard in the telephone if the line is being used, due to the current coming in from the "test" circuit through a third winding on the induction coil and the telephone. Lamps can also be used as signals instead of ordinary annunciators, and as shown on one section of this board, for the subscribers' lines they are placed under the corresponding local jacks, and, for the ring-off, opposite to each pair of cords. This arrangement saves fatigue to the operators. E. O. W.

2371. *Mors-Mandroux Telephone System.* **L. Montillot.** (Électricien, 20. pp. 150–153, Sept. 8, 1900.)—An arrangement for a number of telephones on one common metallic circuit without a central exchange, shown at the Paris Exhibition. The offices are in parallel, and the speaking apparatus is, as usual, brought into circuit by removing the telephone receiver from the hook-switch. The peculiarity is the apparatus for the selective call, and the indication that the circuit is "engaged." In each office is a keyboard with keys numbered to correspond with the stations on the circuit, and one key for "rest"; a clockwork movement causing two axes to turn, which operate to regulate the number and succession of currents of "call," and an electromagnet whose polarised armature carries an escapement controlling a needle which moves over a dial numbered similarly to the stations. When the clockwork is going it turns a horizontal rod running the length of the keyboard as well as a distributing wheel divided into sectors, so that when springs or brushes are suitably arranged to come into contact with these sectors severally, positive and negative currents from the battery can be sent into the circuit in either direction, or with the appropriate number of impulses. These depend upon what key of the board happens to be depressed by the person calling; and to create the proper effect the horizontal bar is furnished with studs which are arranged helicoidally. One key can alone at one time engage one contact, as the bar rotates. When this is effected, all the needles in the entire circuit move step by step to the number called, and there remain until the communication is finished, so that those which are not concerned may see that the circuit is engaged. When the needle has arrived at the desired number, the "calling" key is operated in order to ring the bell at that station. The key is a double current one, and when appropriately connected and operated can cause the armature of a magnet at the distant station to move backwards and forwards as desired. This movement brings a stud on the disc worked by the escapement up against the local bell contact. This stud is arranged differently in each station, so that the process of calling is selective. When the conversation is ended the key of "rest" is depressed at the original station, when the key at first used falls into its place, the clockwork begins to move, one of the springs or brushes comes into play at the distributor and sends alternate currents in number sufficient to bring back the needles of all the stations to their normal positions of "R," or rest. To secure that they take up these positions accurately there is a second electromagnet, whose armature has a click, which prevents the disc, secured with the needle on the same arbour, from moving beyond the proper limits. E. O. W.

2372. *Chicago Telephone Company.* (West. Electn. 27. pp. 81–85, Aug. 11, 1900.)—This article describes with illustrations the fittings, technical arrangements, &c., of the main offices and exchange. The switchboard is of the common-battery relay multiple type. Present capacity 5,400, and space for extension up to 7,500 lines. The "A" or answering board is in 20 sections, each section having 7 panels, each panel 700 multiple jacks, each section having 3 operators' positions, and the greatest distance the operator has to reach being 3½ panels. One section contains jacks for all subscribers. Below the multiple jacks are placed the answering jacks for main subscribers, the number to each operator being apportioned according to the number of calls. The first 6 positions of the board are given up to measured-service lines, and each operator has about 160 answering jacks to attend to. The other positions on the board are devoted to unlimited-service lines, and as the calls are numerous no operator has more than 80 lines. The operation of the "A" or answering board is, briefly, as follows: When a subscriber removes his receiver from its hook, the line relay at the exchange closes, the lamp adjacent to the answering jack lights up, and the operator plugs in with her answering plug; in her cord is a third wire connected to a cut-off relay, which cuts out the line relay and extinguishes the lamp. She then connects over and rings in the usual way. When conversation is finished and receivers hung up the continuity of the battery circuit through the subscribers' instruments is broken. This allows the disconnect relays in the cord circuit to release their armatures and break a shunt across the disconnect lamp signals, thus lighting these signals through the third wire. There is such a signal for each line. The operator can thus disconnect at the proper time, and, doing so, extinguishes the signal.

In the "B" or incoming-trunk board there are 13 sections, each section with 5 panels, and 2 operators' positions, and having all multiple jacks, each panel having 1,100 and space for 400 more. When a call comes in for a main subscriber the operator tests the line called for by tapping the tip of her plug on the rim of the multiple spring jack. If a click is heard, the operator inserts her plug into the "busy-back" jack, which sends back over the trunk line an interrupted buzz, thus giving notice to the calling subscriber as well as to the operator at the distant exchange, that the line called for is in use. If it is free the operator presses a push-button, which is latched and automatically sends an intermittent, alternating current to operate the distant bell. When the subscriber removes his receiver a battery-circuit is completed, actuating an armature which replaces the push-button, and he finds himself in communication with the caller. A lamp disconnect-signal appears when either the telephones are put back or the trunk line is disconnected. The operator then restores the cords to their places.

Each line of both boards has a 1-ampere fuse in its talking circuit, as has each operator's transmitter.

Each exchange has direct trunk lines with every one of the other exchanges, so that no trunking is done through a third exchange except in case of emergency. These trunk lines make up a vast network of wires, binding all the Chicago local exchanges into one complete system, and so systematic and thorough is the working of the trunk lines that a subscriber experiences no appreciable delay when his call is for a number in a branch office other than the one in which his line is answered.

Among modern devices for anticipating every possible need and for saving time are two telephone-ringing dynamotors. These operate on a 220-volt circuit, and furnish alternating current for intermittently ringing the subscribers' lines, and supply the "busy-back" signalling current, the pulsating direct current for party line service, and also a "howler" current, which is used to vibrate rapidly a subscriber's receiver diaphragm when the receiver is left hanging, thus producing a "howling" sound and attracting attention. Also a compresser, driven by a 25-H.P. motor, for a pneumatic tube system used in cleaning out holes about the telephone switchboard, for compression tanks in the elevator system, &c. Fans for heating and ventilating are electrically driven. For the maintenance of the switchboard as well as for the benefit of the operators the air is washed, dried, and forced into the room, heated in cold weather and cooled in summer. It is washed by being forced through fine sprays of running water, and then circulated through tubes with spiral projections to free it of moisture. E. O. W.

2373. *Amsterdam Municipal Telephones.* (Electrician, 45. pp. 573–574, Aug. 3, 1900; from an article in "Municipal Affairs," by **P. Falkenburg** and **J. H. van Zanten.**)—A statistical article in which, among other details, the profits accruing to the municipality from the telephones are shown. There are 3,031 subscribers, a single exchange and one switchboard, horizontal and multiple, with a capacity for 10,800 lines. The overhead conductors are being placed underground and in the canals. There is already a considerable length of 28-pair and 56-pair cables. E. O. W.

2374. *Blut's Telephone Sub-station System.* **Blut.** (Elektrotechn. Zeitschr. 21. pp. 318–321; Discussion, pp. 321–322, April 19, 1900.)—This system is chiefly designed for connecting a number of substations to a line communicating with an exchange-office, so that one or other of these substations can be connected to the line, and while so connected it is not possible to switch the other substations into circuit. For this purpose, each substation is provided with a special switch comprising two separable lever-arms oscillating about a common axis, and normally held together by a spring, one arm (*a*) bearing an armature and the other (*b*) a contact-piece adapted to be brought into or out of connection with the line; the arm *a* has an extension acted upon by a spring in such a manner as to hold the arms in an intermediate position, so that the armature on the one side of arm *a* is separated from its controlling electromagnet, and the contact on the other side of arm *b* is separated from the line. The upper or free end of arm *b* is **V**-shaped, and lies opposite a **V**-shaped projection on the spring-controlled hook-lever for the receiver, in such a position that, if the receiver is taken off its hook, the arm *b* will be moved so as to bring its contact into connection with the line; if, however, the electromagnet has previously attracted the armature, as described later, the arm *b* will be locked so as to keep it out of contact with the line. Above the hook-lever, and actuated thereby, is a lever (*h*) which, when the receiver is taken off the hook and the line contact made, connects a battery to a local circuit including the controlling electromagnets at all the substations on this line; if, however, the receiver at another substation has been previously removed, so that the arms *a*, *b* have moved towards the controlling electromagnet, the end of the arm *b* will engage the hook-lever and thereby prevent the lever *h* from moving far enough to complete the battery circuit at that substation. By these means, at any of these substations, by taking the receiver off the hook, it is possible to connect the instruments to the line, and at the same time prevent any of the other substations from being connected to line, the arms *a* and *b* separating at this calling station, when the electromagnets are energised. In order to enable the exchange to be put into connection with any one of the substations, one of the latter is arranged as a secondary exchange, and has its spring placed so as to hold the arm *b* normally in contact with the line. By these means, this secondary exchange will receive the call from the exchange proper, and can connect the desired substation to the line through a separate wire so as to enable it to be rung up by the exchange, the secondary exchange being simultaneously cut out of circuit with the exchange proper; on the subscriber at the desired substation taking the receiver off the hook, this substation is connected to the line as described above. At each substation there is an indicator showing whether the line is clear or not, *i.e.*, whether the armature has been attracted or not.

C. K. F.

REFERENCES.

2375. *Telephone Exchange Office in Berlin.* **Lindow.** (Elektrotechn. Zeitschr. 21. pp. 621–628, July 26, 1900.)—In this paper there is given a very detailed description, including dimensions, of all the apparatus at the new exchange office in Franzosische Strasse, which is capable of dealing with 10,600 subscribers' lines. Drawings and photographs are included in the original paper. C. K. F.

2376. *High-speed Telegraphy.* **Munier.** (Écl. Électr. 23. pp. 241–246, May 19 328–338, June 2; 367–376, June 9; 456–470, June 23; and 489–498, June 30, 1900.)—A description of various methods.